Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

Course Code: AE307

Course Name: SIGNALS AND SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Represent the sequence $x(n) = \{3,2,-1,6,4,1\}$ as sum of shifted scaled impulses, where $x(0) = 2$. Also sketch the signal. (3)

b) Find whether the signal $x(t) = \begin{cases} t-2, & -2 \le t \le 0 \\ 2-t, & 0 \le t \le 2 \\ 0 & Otherwise \end{cases}$ is energy or power signal. Also find the energy and power of the signal. (5)

c) Obtain the linear convolution of $x_1(t)$ and $x_2(t)$, where $x_1(t) = t\,u(t)$ and $x_2(t) = e^{-2t}u(t)$, where $u(t)$ represents the unit step signal. (7)

2 a) Check whether or not the given system $y(t) = x(t-2) + x(2-t)$ is linear, time invariant, causal, memory less and stable, where $x(t)$ represents the input and $y(t)$ represents the output. (5)

b) Find even and odd components of the following signals (5)

i. $x(t) = \cos(t) + \sin(t) + \cos(t)\sin(t)$

ii. $x(n) = \{-2,1,2-1,3\}$, where $x(0) = 2$

c) Determine the step response of the system described by the difference equation $y[n] - \frac{1}{2}y[n-1] = x[n]$ for $n = 0,1,2,3,4$ where $x[n]$ represents the input and $y[n]$ represents the output. Initial condition $y[-1] = -2$ (5)

3 a) Find whether the following signals are stable or not if $x(t)$ represents input and $y(t)$ represents output and $h(t)$ represents impulse response. (5)

i. $y(t) = e^{x(t)}$, where $|x(t)| \le 8$ ii. $h(t) = e^{2t}u(t)$

iii. $y(n) = \delta(n) + \frac{1}{2}\delta(n-1) + \frac{1}{4}\delta(n-2)$ iv. $h(n) = a^n$ for $0 < n < 11$

v. $h(t) = (t+5)u(t)$

b) Write short notes on differential and difference equation representation of LTI systems (5)

c) Find the convolution between $x(n) = 2^n u(n)$ and $h(n) = \left(\frac{1}{3}\right)^n u(n)$ (5)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Explain the Hilbert transform and its properties in detail. (10)

b) Find the Discrete Time Fourier Transform of $x[n] = \begin{cases} 2^n, & 0 \leq n \leq 9 \\ 0, & Otherwise \end{cases}$ (5)

5 a) State and explain the sampling theorem and aliasing for band limited signals showing the sampled spectrum. (8)

b) Explain the conditions for distortion less transmission through an LTI system (7)

6 a) Using Fourier Transform, find the convolution of the signals $x_1(t) = te^{-t}u(t)$ and $x_2(t) = te^{-2t}u(t)$ (10)

b) One period of the DTFS coefficients of a signal is given by $X[k] = \left(\frac{1}{2}\right)^k$ for $0 \leq k \leq 9$. Find the time domain signal $x(n)$ by assuming $N = 10$. (5)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Determine the transfer function and the impulse response for the causal linear time-invariant system described by the differential equation using Laplace transform. (6)

$$\frac{d^2}{dt^2}y(t) + 3\frac{d}{dt}y(t) + 2\,y(t) = 2\frac{d}{dt}x(t) - 3x(t)$$

b) A system has the transfer function $H(S) = \frac{3s-1}{s^2+5s-6}$. (9)

i. Find the impulse response of the system by assuming that the system is

a) Stable

b) Causal

ii. Can this system be both stable and causal?

c) Determine the initial and final values of the signal $x(t)$ whose Laplace transform is $X(S) = \frac{7s+10}{s(s+2)}$ (5)

8 a) Find the difference equation description of the system with transfer function $H[Z] = \frac{5z+2}{z^2+3z+2}$ (4)

b) Find the inverse Z transform of $X[z] = \frac{1-z^{-1}+z^{-2}}{\left(1-\frac{1}{2}z^{-1}\right)(1-2z^{-1})(1-z^{-1})}$, if ROC is (8)

i. $1 < |Z| < 2$

ii. $\frac{1}{2} < |Z| < 1$

c) Determine the z transform and Region of Convergence (ROC) of the signal $x(n) = a^n u(n) - b^n u(-n-1)$ (8)

9 a) Determine the unit step response for the causal LTI system described by the difference equation using Z-Transform. (10)

$$y[n] = 7y[n-1] - 12y[n-2] + 2x[n] - x[n-2]$$

b) Determine the unit step response for the causal LTI system described by the differential equation using Laplace Transform. (10)

$$\frac{d^2}{dt^2}y(t) + 3\frac{d}{dt}y(t) + 2y(t) = \frac{d}{dt}x(t) + 10x(t)$$

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