USN

10EE52

Fifth Semester B.E. Degree Examination, June/July 2023
Signals and Systems

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Check whether the given signals below are periodic or aperiodic. If periodic find the fundamental period.
   i) $x_1(t) = \text{Cos}(2t) + \text{Sin}(3t)$
   ii) $x_2(t) = \text{Sin}^2 t$
   iii) $x_3[n] = (-2)^n$ **(06 Marks)**

b. Show that $y[n] = x[n/2]$ is
   i) BIBO stable
   ii) Non causal
   iii) Not memoryless
   iv) Not time invariant system **(06 Marks)**

c. Discretize the given signal defined by the equation
$x(t) = t\,u(t) - 2\,(t-1)\,u(t-1) + (t-2)\,u(t-2)$ at sampling frequency 2Hz. Represent the descretised signal x[n] in any one form. Hence perform the following operations on x[n]
i) $y[n] = x[2n-1]$ ii) $y[n] = x\left[\frac{n}{2}+1\right]$ **(08 Marks)**

2 a. Find the convolution of the following
   i) $x[n] = \alpha^n u[n]$; $h[n] = \beta^n u[n]$ for $\alpha \neq \beta$
   ii) $x[n] = \{1 \ \underset{\uparrow}{2} \ 1\}$; $h[n] = \{\underset{\uparrow}{1} \ -1 \ -1\}$ **(06 Marks)**

b. For each of the impulse response given below, determine whether the system is i) memoryless ii) Causal iii) Stable . Given $h(t) = e^{-|t|}$ **(06 Marks)**

c. Find the forced response of the system described by the equation $4y[n] + 4y[n-1] + y[n-2] = x[n]$ with input $x[n] = 4^n u[n]$. Initial conditions being $y(-1) = 0$; $y(-2) = 1$. **(08 Marks)**

3 a. Find the step response of an LTI system whose impulse response is given as $h(t) = t^2 u(t)$. Hence plot the output. **(06 Marks)**

b. Draw the direct form – I and Direct Form – II block diagrams for the difference equation given below :
$$y[n] + \frac{1}{2}y[n-1] - y[n-2] = 3x[n-1] + 2x[n-2]$$ **(06 Marks)**

c. Find the output of the system described by the equation
$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = x(t)$$
Given $x(t) = e^{-t}u(t)$; $y(0) = -\frac{1}{2}$; $\left.\frac{dy(t)}{dt}\right|_{t=0} = \frac{1}{2}$. **(08 Marks)**

4 a. Find the complex exponential Fourier service of f(t) shown in Fig Q4(a)

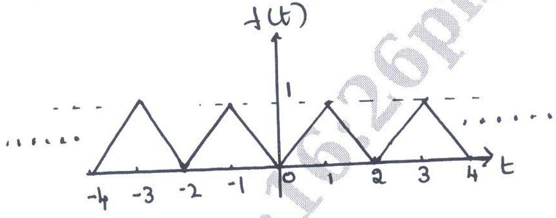

Fig Q4(a) **(08 Marks)**

b. Determine the DTFS coefficients of the signal $x[n] = \mathrm{Cos}\left(\frac{\pi n}{3}\right)$ **(06 Marks)**

c. State and prove Parseval's theorem in discrete time Fourier series. **(06 Marks)**

PART – B

5 a. State and prove the following properties in continuous time Fourier Transform
   i) Time Shifting
   ii) Differentiation in time **(06 Marks)**

b. A rectangular pulse signal is defined by the equation

$$x(t) = \begin{cases} 1 & |t| \leq T_1 \\ 0 & |t| > T_1 \end{cases}$$

Using the analysis equation of Fourier Transform, find the FT of x(t). Also find the phase and magnitude spectrum. **(06 Marks)**

c. Consider a causal, LTI system 'S' having frequency response $H(w) = \frac{jw + 4}{6 - w^2 + 5jw}$.

   i) Obtain the differential equation for the system 'S'
   ii) Determine the impulse response h(t)
   iii) What is the output of 'S' when the input is $x(t) = e^{-4t}u(t)$ **(08 Marks)**

6 a. From the definition of DTFT, find the Fourier transform of $x[n] = \alpha^{|n|}$ for $\alpha < 1$ **(06 Marks)**

b. Using the properties of DTFT, obtain the Fourier transform of the following

   i) $x_1[n] = \left(\frac{1}{2}\right)^n u[n] + 2^n u[-n]$

   ii) $x_2[n] = n\,u[n] - u[n-1]$ **(06 Marks)**

c. Determine the inverse Fourier transform of

   i) $|x(e^{j\Omega})| = \begin{cases} 1 & 0 \leq |\Omega| < \pi/4 \\ 0 & \pi/4 < \Omega \leq \pi \end{cases}$ Use synthesis equation $x(e^{j\Omega}) = \frac{-3\Omega}{2}$

   ii) $x(e^{j\Omega}) = \dfrac{3 - \frac{1}{4}e^{-j\Omega}}{-\frac{1}{16}e^{-2j\Omega} + 1}$ Use partial fraction method. **(08 Marks)**

7 a. Find the Z transform of the signal $x[n] = -u[-n-1] + \left(\frac{1}{2}\right)^n u[n]$. Also specify its R.O.C. **(06 Marks)**

b. State and prove the following properties of Z transform
i) Time reversal ii) Convolution. **(06 Marks)**

c. Find the impulse response of the system described by the difference equation
$y[n] - \frac{5}{6}y[n-1] + \frac{1}{6}y[n-2] = x[n]$. **(08 Marks)**

8 a. By exploiting the properties of Z-transform find the Z transform of the sequence given in Fig Q8(a)

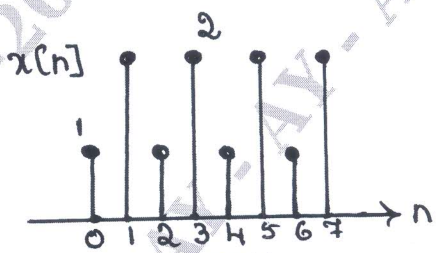

Fig Q8(a) **(06 Marks)**

b. State and prove the initial value theorem. Hence find the initial value x[0] for the signal with transform

$$x(z) = \frac{z^3 - \frac{3}{4}z^2 + 2z - \frac{5}{4}}{(z-1)\left(z-\frac{1}{3}\right)\left(z^2 - \frac{1}{2}z + 1\right)}$$ **(06 Marks)**

c. Find the ZIR, ZSR for the following difference equation using Z transform
$3y[n] - 4y[n-1] + y[n-2] = x[n]$ with $x[n] = \left(\frac{1}{2}\right)^n u[n]$, $y(-1) = 1$, $y(-2) = 2$. **(08 Marks)**

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