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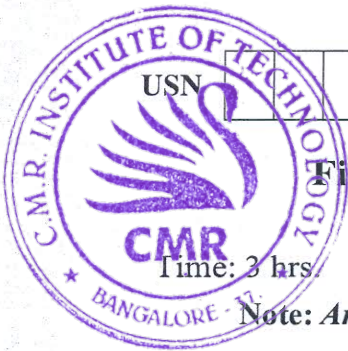
17EE54

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Signals and Systems

Time: 3 hrs.   Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1   a.   Distinguish between :
        i)   Continuous and discrete time signals
        ii) Even and odd signals
        iii) Periodic and non-periodic signals
        iv) Power and energy signals.   **(08 Marks)**
    b.   Find the even and odd components of the signal $x(t) - e^{-2t}$ cost.   **(04 Marks)**
    c.   A triangular pulse signal x(t) is depicted in Fig.Q1(c). Sketch each of the following signals derived from x(t).
        i)   x(3t)
        ii) x(3t + 2)
        iii) x(2(t+ 2))
        iv) x(3t) + x(3t + 2)

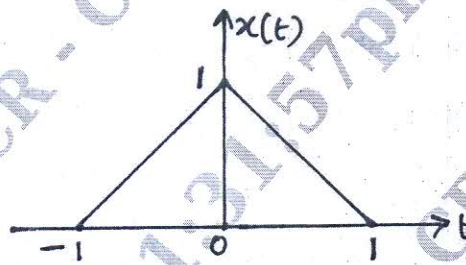Fig.Q1(c)   **(08 Marks)**

OR

2   a.   For each of the following signals, determine whether it is periodic, and if it is, find the fundamental period :   i) $x(t) = \sin^3(2t)$ ii) $x[n] = [-1]^{n^2}$ iii) $x[n] = \cos[2n]$.   **(06 Marks)**
    b.   Categorize each of the following signals as an energy signal or a power signal and find its corresponding value.

   i) $x(t) = \begin{cases} t; & 0 \le t \le 1 \\ 2-t; & 1 \le t \le 2 \\ 0; & \text{otherwise} \end{cases}$

   ii) $x(n) = \begin{cases} n; & 0 \le n \le 5 \\ 10-n; & 5 \le n \le 10 \\ 0; & \text{otherwise} \end{cases}$ **(06 Marks)**

    c.   Check whether the following system is :
        i)   Static or dynamic
        ii) Linear or non – linear
        iii) Causal or non-causal
        iv) Time invariant or time variant
        Justify the answer. $y[n] = \log_{10}|x[n]|$.   **(08 Marks)**

Module-2

3 a. Find the convolution sum of the sequences :

$x[n] = \{\underset{\uparrow}{3}, 4, 1, 2\}$ and $\quad h[n] = \{\underset{\uparrow}{1}, 1, 2, 3\}$

using graphical method. **(08 Marks)**

   b. For the following impulse responses, determine whether the corresponding system is memoryless ; causal and stable. Justify the answer :

i) $h(t) = e^{at} u(t); a < 0$

ii) $h[n] = \left[\dfrac{1}{2}\right]^n u[n]$. **(06 Marks)**

   c. Draw direct form I and direct form II implementations of the system described by the difference equation : $y[n] + \dfrac{1}{4} y[n-1] + \dfrac{1}{8} y[n-2] = x[n] + x[n-1]$. **(06 Marks)**

OR

4 a. Evaluate the convolution integral for a system with input x(t) and impulse response h(t), given by :

$x(t) = \begin{cases} 1, & 0 < t < 2 \\ 0, & \text{otherwise} \end{cases} \qquad h(t) = e^{-t} u(t)$. **(08 Marks)**

   b. Find the step response of the first – order recursive system with impulse response. $h[n] = \alpha^n u[n]$, assuming that $|\alpha| < 1$. **(04 Marks)**

   c. Find the complete solution for the first–order recursive system described by difference equation : $y[n] - \dfrac{1}{4} y[n-1] = x[n]$, if input $x[n] = \left[\dfrac{1}{2}\right]^n u(n)$ and the initial condition is $y[-1] = 8$. **(08 Marks)**

Module-3

5 a. Find the Fourier transform of the following signals :

i) $x(t) = e^{2t} u(-t)$

ii) $x(t) = e^{-|t|}$. **(06 Marks)**

   b. State and prove convolution property of continuous time Fourier transform. **(08 Marks)**

   c. Find the Fourier transform of the system output, for the following input and impulse response : $x(t) = 3e^{-t} u(t)$ and $h(t) = 2e^{-2t} u(t)$. **(06 Marks)**

OR

6 a. Prove differentiation in time property of CTFT. **(06 Marks)**

   b. Determine the time-domain signal corresponding to the following Fourier transform.

$X(j\omega) = \dfrac{-j\omega}{(j\omega)^2 + 3j\omega + 2}$. **(08 Marks)**

   c. Find the frequency response of LTI system described the differential equation :

$\dfrac{d^3 y(t)}{dt^3} + \dfrac{6 d^2 y(t)}{dt^2} + \dfrac{5 dy(t)}{dt} + 4y(t) = 3x(t)$. **(06 Marks)**

Module-4

7 a. State and prove time shifting property of discrete time Fourier transform. **(06 Marks)**

b. Find the Fourier transform of x[n], where

$x[n] = 1; \quad 0 \le n \le 4$

$\quad\quad = 0; \quad \text{otherwise}$ **(06 Marks)**

c. Find the inverse DTFT of $X(e^{j\Omega}) = \dfrac{1}{3} \dfrac{e^{j\Omega} + 1 + e^{-j\Omega}}{1 - a\ e^{-j\Omega}}$. **(08 Marks)**

OR

8 a. State and prove Parseval's theorem in DTFT. **(06 Marks)**

b. A causal system is represented by the following difference equation :

$$y[n] + \frac{1}{4} y[n-1] = x[n] + \frac{1}{2} x[n-1]$$

Find the transfer function of the system. **(06 Marks)**

c. Determine the impulse response and frequency response of the LTI system defined by

$y[n] = x[n] + by[n-1]$. **(08 Marks)**

Module-5

9 a. Define Region of Convergence. List any five properties of RoC. **(06 Marks)**

b. Prove the following properties of the z – transform.

i) Time shift property

ii) Differentiation in the z-domain. **(08 Marks)**

c. Find the z-transform of x[n],

$$x[n] = u[n-2] * \left(\frac{2}{3}\right)^n u[n].$$ **(06 Marks)**

OR

10 a. Find the time – domain signal corresponding to the z-transform X(z),

$$X(z) = \frac{\left(\frac{1}{4}\right)z^{-1}}{\left(1 - \left(\frac{1}{2}\right)z^{-1}\right)\left(1 - \left(\frac{1}{4}\right)z^{-1}\right)} \text{ with RoC } \frac{1}{4} < |z| < \frac{1}{2}.$$ **(07 Marks)**

b. Find the transfer function and impulse response of a causal LTI system if the input to the system is $x[n] = \left(-\frac{1}{3}\right)^n u[n]$ and the output is $y[n] = 3(-1)^n u[n] + \left(\frac{1}{3}\right)^n u[n]$. **(08 Marks)**

c. A causal system is represented by the difference equation $y[n] + \frac{1}{4} y[n-1] = x[n] + \frac{1}{2} x[n-1]$

i) Find H(z) and corresponding RoC

ii) Is the system stable? Give reason. **(05 Marks)**

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