CBCS SCHEME

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15EE54

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Signals and Systems

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define even and odd signals. Find the even and odd components of the signal : $x(n) = u(n) - 2u(n-5) + u(n-10)$. **(06 Marks)**

b. Determine where the signal in Fig.Q1(b) is an Energy or a power single and hence determine the corresponding value of power or energy of the signal.

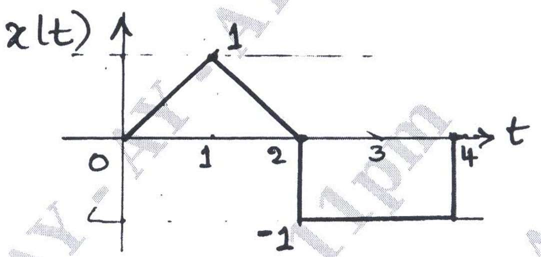

Fig.Q1(b) **(06 Marks)**

c. A discrete time system is represented as : $y(n) = \log[x(n)]$. Identify whether the system is linear, time – invariant, Causal and Memoryless. **(04 Marks)**

OR

2 a. If x(t) is a periodic signal, then show that : $\int_{\alpha}^{\beta} x(t)dt = \int_{\alpha+T}^{\beta+T} x(t)dt$. **(02 Marks)**

b. Define the elementary signals $\delta(n)$ [impulse], u(n) [unity] and r[n] [ramp] and hence obtain the relation between them. **(06 Marks)**

c. Consider a RC circuit as sown in Fig.Q2(c). Find the relation between the input x(t) and output y(t) for the system with $x(t) = V_S(t)$ and $y(t) = V_C(t)$. Determine whether the system is linear, time invariant, causal and stable.

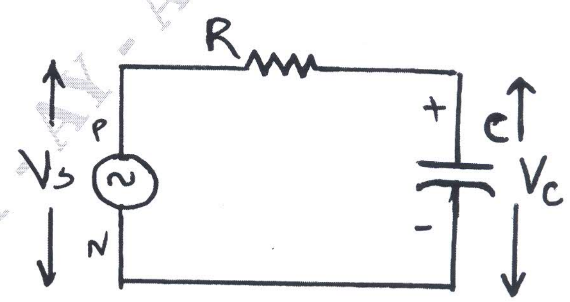

Fig.Q2(c) **(08 Marks)**

Module-2

3 a. Prove the following properties of convolution sum :
   i) Associative
   ii) Distributive property. **(04 Marks)**

b. Obtain the convolution sun of $x(n) = \alpha^n u(n)$ and $h(n) = \beta^n u(n)$. **(06 Marks)**

c. Draw the direct form I and direct form II for the following systems.

   i) $y(t) - \frac{1}{2}y(n-1) + \frac{1}{4}y(n-2) = x(n) + 2x(n-1)$

   ii) $2\frac{d^2y(t)}{dt^2} + \frac{dy(t)}{dt} + 3y(t) = x(t) + \frac{d^2x(t)}{dt^2}$. **(06 Marks)**

OR

4 a. Consider a continuous time LTI system has an input signal

$$x(t) = \begin{cases} A & 0 \le t \le T \\ 0 & \text{other values of } t \end{cases}$$

and has an impulse signal

$$h(t) = \begin{cases} A & 0 \le t \le 2T \\ 0 & \text{other value of } t \end{cases}$$

Find the output signal $y(t) = x(t) * h(t)$, using convolution integral. **(06 Marks)**

b. Show that : $x(t) * u(t - t_0) = \int_{-\infty}^{(t-t_0)} x(t - t_0)dt$. **(03 Marks)**

c. Find the complete response of a system described by the equation :
$y(n) - \frac{1}{4}y(n-1) - \frac{1}{8}y(n-2) = x(n) + x(n-1)$ with $y(-1) = 2$ and $y(-2) = -1$, as initial conditions, and input $x(n) = 2^n u(n)$. **(07 Marks)**

Module-3

5 a. Plot the magnitude and phase spectrum for the Fourier transform of the signal : $x(t) = e^{-a|t|}$. **(08 Marks)**

b. Show that :
If $x(t) \xleftrightarrow{FT} X(\omega)$, then $\frac{d}{dt}[x(t)] \xleftrightarrow{FT} j\omega \cdot X(\omega)$. **(04 Marks)**

c. Find the inverse Fourier transform of the signal : $X(\omega) = \frac{j\omega + 12}{(j\omega)^2 + 5(j\omega) + 6}$. **(04 Marks)**

OR

6 a. Find the Fourier transform of :
   i) $x(t) = 1$ ii) $x(t) = u(t)$. **(06 Marks)**

b. Calculate the energy of the signal : $x(t) = 4 \sin c\left(\frac{t}{5}\right)$ using Parsevats theorem. **(06 Marks)**

c. Evaluate : $\int_{-\infty}^{\infty} \frac{4}{(w^2+1)^2} = dw$ using Fourier transform. **(04 Marks)**

Module-4

7 a. Prove the modulation (time domain) property of Discrete Time Fourier Transform (DTFT). **(04 Marks)**

b. Evaluate the DTFT of the signal : $\left(\frac{1}{2}\right)^n u(n-4)$. **(04 Marks)**

c. Given input signal : $x(n) = n \cdot \left(-\frac{1}{2}\right)^n \cdot u(n)$, without evaluating $x(\Omega)$, find $y(n)$, if $y(\Omega)$ is given by ;

i) $Y(\Omega) = e^{j3\Omega} \cdot X(\Omega)$

ii) $Y(\Omega) = \frac{d}{d\Omega}[X(\Omega)]$

iii) $Y(\Omega) = \frac{d}{d\Omega}\left[e^{-j2\Omega} \cdot [X\left(e^{j(n+\pi/4)}\right) - X\left(e^{j(n-\pi/4)}\right)\right]$. **(08 Marks)**

OR

8 a. Obtain the DTFT of a rectangular pulse signal : $x(n) = \begin{cases} 1 & \text{for } |n| \le m \\ 0 & \text{for } |n| > m \end{cases}$ and plot its spectrum. **(06 Marks)**

b. Find the inverse Fourier transform of : $X(\Omega) = \cos^2(\Omega)$. **(04 Marks)**

c. Compute the frequency response and the impulse response of the system described by the difference equation : $y(n) + \frac{1}{2}y(n-1) = x(n) - 2x(n-1)$. **(06 Marks)**

Module-5

9 a. Define Z-transform of a discrete time signal x(n). Determine the z-transform of the signal : $x(n) = \alpha^n u(n) + \beta^n u(-n-1)$. **(06 Marks)**

b. Prove the following properties of Z-transform :

i) Convolution (time domain) property

ii) Differentiation (z – domain) property. **(04 Marks)**

c. Find the inverse Z-transform for the following signals :

i) $x(z) = \dfrac{\left(1 - \frac{1}{2}z^{-1}\right)}{\left(1 + \frac{3}{4}z^{-1} + \frac{1}{8z^{-2}}\right)}$

ii) $x(z) = \ln[1 + z^{-1}]$. **(06 Marks)**

OR

10 a. What is ROC? Specify the properties of ROC and mention its significance. **(04 Marks)**

b. Find the convolution of $x_1(n) = \{2, 3, 4\}$ and $x_2(n) = \{1, 5, 5\}$ using Z-transform. **(04 Marks)**

c. A linear time invariant system is described by the difference equation : $y(n) = ay(n-1) + x(n)$.

i) Determine the transfer function of the system

ii) Determine the impulse response of the system

iii) Determine the step response of the system. **(08 Marks)**

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