Birla Institute of Technology and Science, Pilani
Mid-Semester Examination: ECE / EEE / INSTR F243: Signals and Systems
Marks: 50 AY: 2022-23, Semester: II Date: 18-March-2023, Saturday
Time: 90 minutes CLOSED BOOK Pages: 02

Q1 [12]

a. Consider the signal shown in figure 1.

$y(t) = \left(\frac{-1}{2}\right) x(-3t + 3)$

(i) Sketch the signal $x(t)$.

(ii) Sketch the even and odd part of $x(t)$.

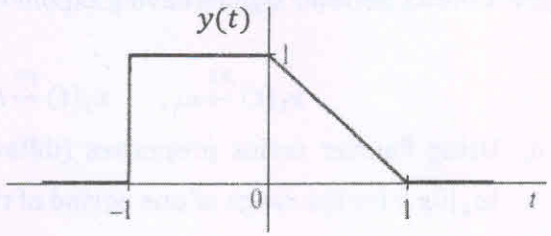

Figure 1

b. A causal LTI system with input $x(t)$ and output $y(t)$ is described as

$\frac{dy(t)}{dt} + y(t) = \frac{dx(t)}{dt} - x(t);$

Find the output $y(t)$ of the system if the input is $x(t) = e^{-t}u(t)$.

All the sketches need to be clear and legible, with proper labeling of the x-axis and y-axis values

Q2 [13]

Determine and sketch the overall impulse response ($H[n]$) of the system shown in figure 2,

where

$h_1[n] = (2)^n u[-n];$

$h_2[n] = (a)^n u[n];$

$h_3[n] = \delta[n] - (a)\delta[n-1];$

$h_4[n] = [n-1]u[n];$

$h_5[n] = \delta[n] + nu[n-1];$

$H[n]$ should be sketched for range $-5 \leq n \leq 5$

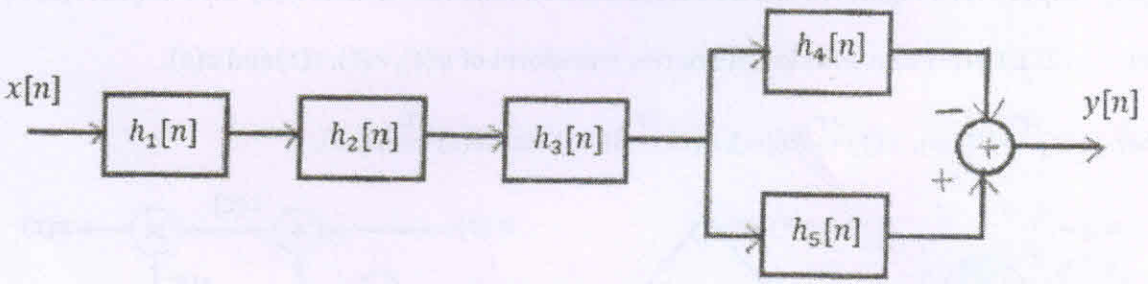

Figure 2

All the sketches need to be clear and legible, with proper labeling of the x-axis and y-axis values

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Q3 Figure 3 shows periodic signals having exponential Fourier series coefficients as shown below: **[13]**

$$x_1(t) \overset{FS}{\leftrightarrow} a_k, \quad x_2(t) \overset{FS}{\leftrightarrow} b_k, \quad \text{and} \quad x_3(t) \overset{FS}{\leftrightarrow} c_k$$

a. Using Fourier series properties (differentiation and linearity), compute a_k. Sketch $|a_k| vs\ k$ for the range of one period of the signal $x_1(t)$.

b. What is the relationship between $x_1(t)$ and $x_2(t)$? Obtain b_k in terms of a_k.

c. What is the relationship between $x_1(t)$ and $x_3(t)$? Obtain c_k in terms of a_k.

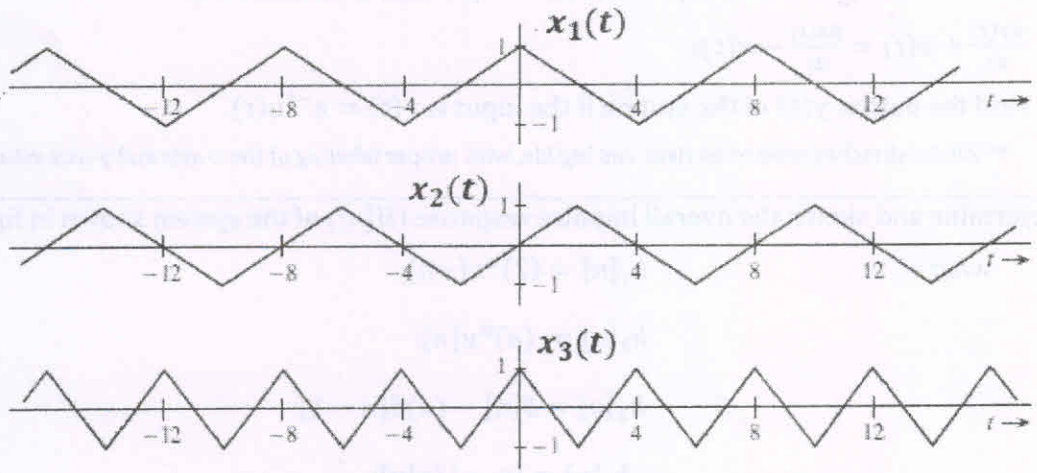

Figure 3

All the sketches need to be clear and legible, with proper labeling of the x-axis and y-axis values

Q4 Figure 4a shows two bandlimited signals $m(t)$ and $p(t)$, having Fourier transform $M(j\omega)$ and $P(j\omega)$, respectively. Figure 4b shows a transmission scheme. Assume $q(t) = 2\cos(100t)$, and $s(t) = q(2t)$. Determine and sketch Fourier transform of $q(t), r(t), s(t)$ and $z(t)$. **[12]**

where $q(t) \overset{FT}{\leftrightarrow} Q(j\omega)$, $r(t) \overset{FT}{\leftrightarrow} R(j\omega)$, $s(t) \overset{FT}{\leftrightarrow} S(j\omega)$, and $z(t) \overset{FT}{\leftrightarrow} Z(j\omega)$,

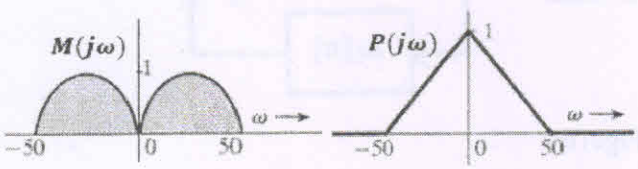

Figure 4a

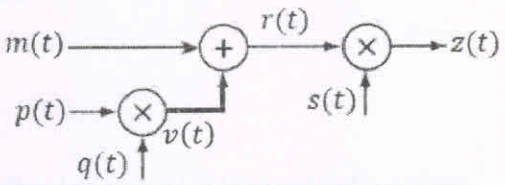

Figure 4b

All the sketches need to be clear and legible, with proper labeling of the x-axis and y-axis values