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15EE54

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

Signals and Systems

Time: 3 hrs. Max. Marks: 80

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Missing data, if any, may be suitably assumed.

Module-1

1 a. Find the even and odd components of each of the following signals.

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

$x(t) = 1 + t + 3t^2 + 5t^3 + 9 + 4$

$x(t) = 1 + 1\cos t + t^2 \sin t + t^3 \sin t \cos t$

$x(t) = e^{j2t}$. **(08 Marks)**

b. State whether the following signals given are periodic or not. If periodic, find the fundamental period :

i) $x(t) = \cos(2\pi t)\sin(4\pi t)$

ii) $x(n) = \cos\left[\frac{n\pi}{2}\right] + \sin\left[\frac{n\pi}{4}\right]$. **(08 Marks)**

OR

2 a. The trapezoidal pulse shown in Fig.Q2(a), find the total energy.

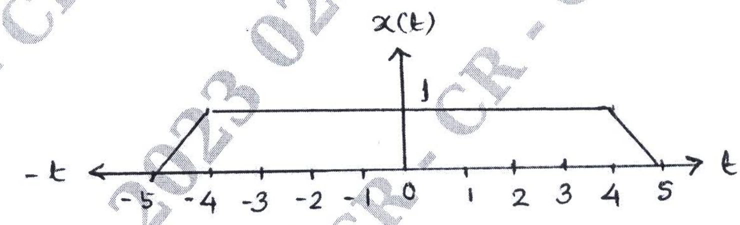

Fig.Q2(a) **(08 Marks)**

b. Sketch and label for each of the following signals for given signals for given signal x(t) show in Fig. Q2(b).
i) $x[2(t-2)]$ ii) $x(-2t+1)$.

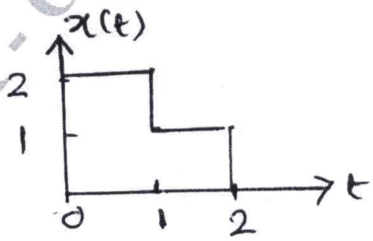

Fig.Q2(b) **(04 Marks)**

c. Test whether the following systems are stable or not :
i) $h(t) = t\,e^{-at}\,u(t)$
ii) $h(t) = e^{-4t}\,u(t-4)$. **(04 Marks)**

Module-2

3 a. Determine the convolution sum of two given sequences :

$x[n] = \left\{1, \underset{\uparrow}{2}, 3, 4\right\}$ and $x[n] = \left\{\underset{\uparrow}{1}, 1, 3, 2\right\}$. **(08 Marks)**

b. Find the convolution sum of two finite duration sequences :

$h[h] = \alpha^n u[n]$ for all n ; $x[n] = \beta^n u(n)$ for all n i) when $\alpha \neq \beta$ ii) when $\alpha = \beta$. **(08 Marks)**

OR

4 a. Find the output response of the system describe by a differential equation :

$$\frac{d^2y(t)}{dt^2} + 6\frac{dy(t)}{dt} + 8y(t) = \frac{dx(t)}{dt} + 2x(t) .$$

The input signal $x(t) = e^{-t}u(t)$ and initial conditions are $y(0) = 2$ $\frac{dy(0)}{dt} = 3$. **(10 Marks)**

b. Draw the direct form I and direct form II implementation of the following differential equation

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

Module-3

5 a. State and prove the following FT properties :

i) Linearity

ii) Time shift property. **(08 Marks)**

b. Find the FT of the following signals :

i) $x(t) = e^{-2t}u(t-3)$

ii) $x(t) = e^{-4|t|}$. **(08 Marks)**

OR

6 a. Use partial fraction expansion to determine the inverse FT for following signals :

i) $X(j\omega) = \frac{j\omega + 1}{(j\omega)^2 + 5j\omega + 6}$

ii) $X(j\omega) = \frac{2j\omega + 1}{(j\omega + 2)^2}$. **(10 Marks)**

b. The differential equation of a system is given by

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

Find the frequency response of the system, also find the impulse response. **(06 Marks)**

Module-4

7 a. State and prove the DTFT properties :

i) Time shift property

ii) Frequency shift property. **(08 Marks)**

b. State and prove the Parseval's theorem as applied to DTFT. **(08 Marks)**

OR

8 a. Find the DTFT for the following signals :
i) $x[n] = 2^n u[-n]$ i) $x[n] = (\frac{1}{2})^n u(n-4)$. **(10 Marks)**

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

Module-5

9 a. What is region of convergence (RoC)? Mention the properties of RoC. **(08 Marks)**

b. Determine the Z –transform of $x[n] = -u[-n-1] + \left(\frac{1}{2}\right)^n u[n]$ and plot pole – zero location of x(z) in the z – plane. **(08 Marks)**

OR

10 a. Determine the inverse Z –transform of $X(z) = \frac{z}{(3z^2 - 4z + 1)}$ RoC i) $|z| > 1$ ii) $|z| < \frac{1}{3}$. **(06 Marks)**

b. Find the transfer function and impulse response of the system described by the difference equation : $y[n] - \frac{1}{2} y[n-1] = 2x(n-1)$. **(06 Marks)**

c. By using unilateral z – transform, solve the following difference equation :
$y[n] + 3y[n-1] = x[n]$
With $x[n] = u[n]$ and the initial condition $y(-1) = 1$. **(04 Marks)**

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