CBCS SCHEME

USN

15EE54

Fifth Semester B.E. Degree Examination, Jan./Feb. 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. Explain the following signals with respect to continuous time,
i) Exponential Signal
ii) Exponential damped Sino-Soidal Signals
iii) Unit step function
iv) Unit ramp function. **(04 Marks)**

b. The discrete time signal x(n) and y(x) one given below :
$x(n) = \{3, 2, 1, \underset{\uparrow}{0}, 1, 2, 3\}$ and $y(n) = \{-1, -1, -1, -1, \underset{\uparrow}{0}, 1, 1, 1, 1\}$ sketch $z(n) = x(2n) \cdot y(n-4)$. **(06 Marks)**

c. For the trapezoidal pulse x(t) is as shown in Fig.Q1(c) is applied to a differentiator defined by $y(t) = \frac{dx(t)}{dt}$.
Find : i) Resulting output of y(t) of differentiator
ii) The total energy of y(t). **(06 Marks)**

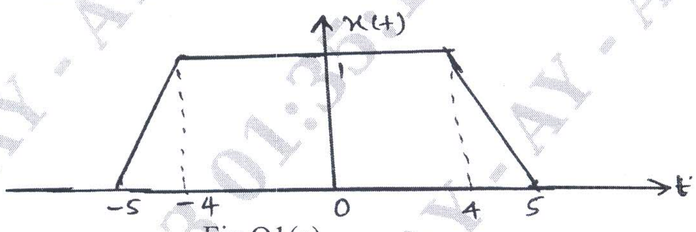

Fig.Q1(c)

OR

2 a. Check whether the signal is periodic or not
$x(t) = \cos\left(\frac{1}{5}\pi t\right)\sin\left(\frac{1}{3}\pi t\right)$. **(04 Marks)**

b. Find the even and odd components of that following signals :
i) $y(n) = \{-1, 1, \underset{\uparrow}{3}, 0, 2, -4\}$
i) $x(t) = \cos t + \sin t + \sin t \cos t$. **(06 Marks)**

c. For given :
$$x(t) = \begin{cases} 1; & \text{for } 0 \le t \le 1 \\ 2-t; & \text{for } 1 \le t \le 2 \\ 0; & \text{otherwise} \end{cases}$$
Sketch the :
i) $y(t) = x(-2t-1)$
ii) $2(t) = x(0.5t+1)$. **(06 Marks)**

Module-2

3 a. Draw the direct form I and direct form II for the differential equation :
$y''(t) = 6y'(t) - 7y(t) = x''(t) + 3x(t)$. **(04 Marks)**

b. Check whether the system is linear, time invariant and causal for following signals :
i) $y_1(t) = \cos[x(t)]$
ii) $y_2(t) = \log_{10}[\,|x(t)|\,]$. **(06 Marks)**

c. Find the zero–input natural response of the system described by difference equation :
$$y(n) - 3y(n-1) - 4y(n-2) = \left(\frac{1}{4}\right)^n.$$
with initial conditions $y(-1) = 5$ and $y(-2) = 0$. **(06 Marks)**

OR

4 a. Determine the step response for the LTI system represented by an impulse response $h(t) = t\,u(t)$. **(04 Marks)**

b. Find the convolution integral for :
$y(t) = u(t+1) * u(t-1)$. **(06 Marks)**

c. Solve the differential equation :
$y''(t) + 5y'(t) + 4y = x'(t)$
with input $x(t) = 2e^{-2t}\,u(t)$ and initial conditions are $y'(0) = 1$ and $y(0) = 0$. **(06 Marks)**

Module-3

5 a. State and prove frequency shift property of Fourier transform. **(04 Marks)**

b. Find the Fourier transform of signal $x(t) = te^{-2t}u(t)$. Obtain the expressions for the magnitude and phase spectra. **(06 Marks)**

c. Find the differential equation that represents the system with the frequency response :

i) $$H_1(J\omega) = \frac{2 + 3J\omega - 3(J\omega)^2}{1 + 2J\omega}$$

ii) $$H_2(J\omega) = \frac{-J\omega}{(J\omega)^2 + 5J\omega + 6}.$$ **(06 Marks)**

OR

6 a. Find the frequency response and impulse response of the system described by differential equation : $\dfrac{dy(t)}{dt} + 8y(t) = x(t)$. **(04 Marks)**

b. State and prove frequency differentiation property of Fourier transform. **(06 Marks)**

c. Find the inverse Fourier transform of
$$X(J\omega) = \frac{J\omega}{(2 + J\omega)^2}$$
Using appropriate properties. **(06 Marks)**

Module-4

7 a. Find DTFT of the signal $x(n) = 2^n u(-n)$. **(04 Marks)**

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

c. State and prove the modulation property with respect to DTFT. **(06 Marks)**

OR

8 a. Let $x(n) = \{3,\ 0,\ 1,\ -\underset{\uparrow}{2},\ -3,\ 4,\ 1,\ 0,\ -1\}$ with DTFT $X(e^{J\Omega})$. Evaluate the following :

i) $X(e^{J\Omega})$

ii) $\int_{-\pi}^{\pi} |X(e^{J\Omega})|^2 d\Omega$

without computing $X(e^{J\omega})$. **(04 Marks)**

b. Find the differential equation that represents the system with frequency response,

$$H(e^{J\Omega}) = 1 + \frac{e^{-J\Omega}}{\left(1 - \frac{1}{2}e^{-J\Omega}\right)\left(1 + \frac{1}{4}e^{-J\Omega}\right)}.$$ **(06 Marks)**

c. Find the time domain signal corresponds to the DTFT is $X\left(e^{-J\Omega}\right) = \cos^2 \Omega$. **(06 Marks)**

Module-5

9 a. State and prove initial value theorem. **(04 Marks)**

b. Find the Z-transform of signal $x(n) = -n\alpha^n u(-n-1)$ using appropriate properties. **(06 Marks)**

c. Find the inverse Z-transform of :

$$X(z) = \frac{3 - 2z^{-1} + 2^{-2}}{(1 - 2^{-1})\left(1 - \frac{1}{3}z^{-1}\right)^2}$$ for ROC : | 2 | > |. **(06 Marks)**

OR

10 a. Find discrete – time sequence x(n) which has Z–transform :

$$X(z) = \frac{-1 + 5z^{-1}}{\left(1 - \frac{3}{2}z^{-1} + \frac{1}{2}z^{-2}\right)}$$ with ROC : | z | > | . **(04 Marks)**

b. Determine the Z – transform of $x(n) = \sin[\Omega n]u(n)$. **(06 Marks)**

c. Solve the differential equation using unilateral Z –transform :

$$y(n) - \frac{3}{2}y(n-1) + \frac{1}{2}y(n-2) = x(n), n \geq 0,$$

if input $x(n) = \left(\frac{1}{4}\right)^n u(n)$ with initial conditions y(–1) = 4 and y(–2) = 10. **(06 Marks)**

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