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10EE52

Fifth Semester B.E. Degree Examination, July/August 2022
Signals and Systems

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the following:
(i) Even and odd signals.
(ii) Continuous time and discrete time signals. **(04 Marks)**

b. Determine whether the following signals are periodic or not. If periodic, determine the fundamental period.

(i) $x(t) = 2\cos t + 3\cos\frac{t}{3}$.

(ii) $x(n) = \cos(\pi + 0.2n)$ **(06 Marks)**

c. Find the sketch the even and odd parts of the following signal,

$$x(t) = \begin{cases} t, & 0 \le t \le 1 \\ 2 - t, & 1 \le t \le 2 \end{cases}$$ **(04 Marks)**

d. For the signal shown in Fig. Q1 (d), sketch and label the following :
(i) $x(t)u(1-t)$
(ii) $x(t)[u(t) - u(t-1)]$.

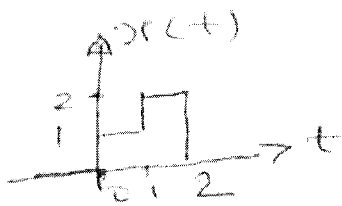

Fig. Q1 (d) **(06 Marks)**

2 a. Obtain the convolution of the following signals:
$x_1(t) = u(t+1)$ and $x_2(t) = u(t-1)$. **(08 Marks)**

b. Prove that : (i) $x(n) * h(n) = h(n) * x(n)$.
(ii) $x(n) * [h_1(n) + h_2(n)] = x(n) * h_1(n) + x(n) * h_2(n)$ **(05 Marks)**

c. Given $x(n) = \left(\frac{1}{2}\right)^n u(n-2)$ and $h(n) = u(n)$. Find the output of LTI system using convolution sum. **(07 Marks)**

3 a. For each of the impulse responses, determine whether the corresponding system is causal and stable. (i) $h(t) = e^{2t}u(t-1)$. (ii) $h(n) = \delta(n)$ **(06 Marks)**

b. Find the response of the system given by the differential equation,

$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 4y(t) = \frac{dx(t)}{dt} \quad y(0) = 0, \left.\frac{dy(t)}{dt}\right|_{t=0} = 1 \text{ and } x(t) = e^{-2t}u(t).$$ **(08 Marks)**

c. Draw the direct form-I and direct form-II implementations for the difference equation,

$$y(n)+\frac{1}{2}y(n-1)-y(n-3)=3x(n-1)+2x(n-2)$$ **(06 Marks)**

4 a. Prove the following properties of continuous time Fourier series:
(i) Linearity
(ii) Time shifting property.
(iii) Frequency shifting property. **(12 Marks)**

b. Obtain the DTFS co-efficients of $x(n)=\cos\left(\frac{6\pi n}{13}+\frac{\pi}{6}\right)$. Draw magnitude and phase spectra. **(08 Marks)**

PART – B

5 a. Determine the Fourier Transform of the following:
(i) $x(t)=e^{-3t}u(t-1)$.
(ii) $x(t)=te^{-2t}u(t)$ **(06 Marks)**

b. Obtain the Inverse Fourier transform of,

$$X(j\omega)=\frac{5j\omega+12}{(j\omega)^2+5j\omega+6}.$$

using partial fraction expansion method. **(06 Marks)**

c. Find the frequency response and the impulse response of the system given by the differential equation,

$$\frac{d^2y(t)}{dt^2}+5\frac{dy(t)}{dt}+6y(t)=-\frac{dx(t)}{dt}$$ **(08 Marks)**

6 a. Determine the Fourier transform of the following:
(i) $x(n)=2^n u(-n)$
(ii) $x(n)=\left(\frac{1}{4}\right)^n u(n+4)$
(iii) $x(n)=u(n)-u(n-6)$. **(09 Marks)**

b. Find the inverse D.T.F.T of,

$$X(e^{j\Omega})=\frac{6}{e^{-j2\Omega}-5e^{-j\Omega}+6}$$

using partial fraction expansion method. **(05 Marks)**

c. Prove the following properties of D.T.F.T :
(i) Frequency shift (ii) Frequency differentiation. **(06 Marks)**

7 a. Determine the z-transform of the following :
(i) $x(n)=na^n u(n)$. (ii) $x(n)=\left(\frac{1}{2}\right)^n u(n)+\left(\frac{1}{3}\right)^n u(-n-1)$
(iii) $x(n)=\alpha^n u(-n)$ **(09 Marks)**

b. Find the inverse z-transform of the following using partial fraction expansion,

$$X(z)=\frac{1-\frac{1}{2}z^{-1}}{1+\frac{3}{4}z^{-1}+\frac{1}{8}z^{-2}};\ |z|>\frac{1}{2}.$$ **(05 Marks)**

c. Prove the following properties of z-transform :
   (i) Time reversal
   (ii) Differentiation in z-domain. **(06 Marks)**

8 a. A Causal system has the input x(n) and output y(n). Find the impulse response of the system, if $x(n) = u(n)$, $y(n) = 2\left(\frac{1}{3}\right)^n u(n)$. **(06 Marks)**

b. A L.T.I system is given by the system function,

$$H(z) = \frac{3 - 4z^{-1}}{1 - \frac{7}{2}z^{-1} + \frac{3}{2}z^{-2}}.$$

Specify the R.O.C. of H(z) and determine h(n) for the following conditions:
   (i) The system is stable.
   (ii) The system is causal. **(06 Marks)**

c. Solve the following difference equation using unilateral z-transform,

$$y(n) - \frac{1}{9}y(n-2) = x(n-1).$$

with $x(n) = 3u(n)$ and the initial conditions $y(-1) = 0$, $y(-2) = 1$. **(08 Marks)**

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