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17EC42

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

Time: 3 hrs.   Max. Marks: 100

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

Module-1

1 **a.** Sketch the even and odd part of the signals shown in Fig.Q1(a)(i) and (ii)
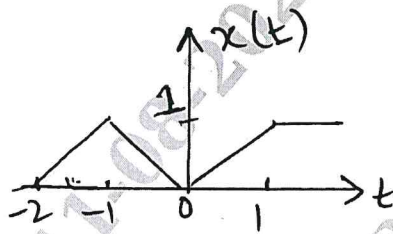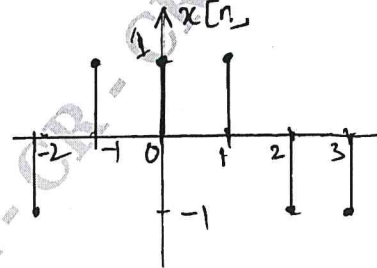

Fig Q1(a)(i)   Fig Q1(a)(ii)   **(10 Marks)**

   b. Determine whether the following systems are memoryless, causal, time invariant linear and stable. i) $y[n] = n\,x[n]$ ii) $y(t) = \cos(x(t))$ **(10 Marks)**

OR

2 **a.** A continuous time signal $x(t)$ and $g(t)$ is shown in Fig.Q2(a)(i) and (ii), express $x(t)$ in terms of $g(t)$.

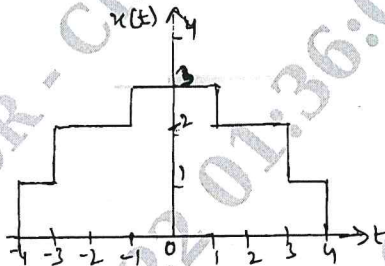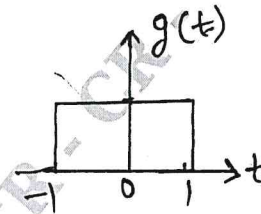Fig.Q2(a)(i)   Fig.Q2(a)(ii)   **(06 Marks)**

   b. Determine whether the following signal is periodic or not. If periodic find the fundamental period. $x(t) = \cos(5\pi t) + \sin(6\pi t)$.   **(04 Marks)**

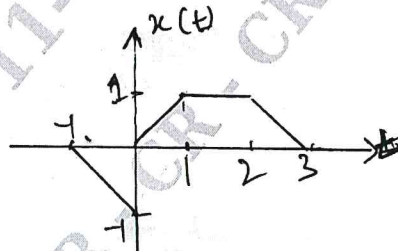   **c.** For the signal $x(t)$ and $y(t)$ shown in Fig.Q2(c)(i) and (ii). Sketch the signal $x(2t)\,y(2t+1)$.
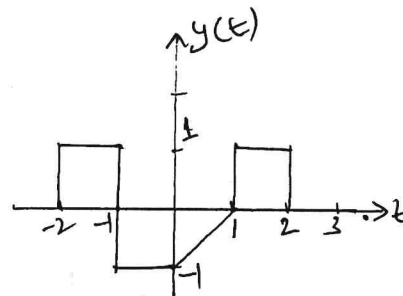

Fig.Q2(c)(i)   Fig.Q2(c)(ii)   **(10 Marks)**

Module-2

3 a. Derive the equation for convolution sum. **(06 Marks)**

b. State and prove commutative property of convolution sum. **(04 Marks)**

c. Compute the following convolution

   i) $y(t) = u(t + 1) * u(t - 2)$ ii) $y[n] = \beta^n u[n] * [n - 3]$. **(10 Marks)**

OR

4 a. Compute the convolution integral of $x_1(t)$ and $x_2(t)$ given $x_1(t) = \text{Cos } \pi t(u(t + 1) - u(t - 3))$ $x_2(t) = u(t)$. **(10 Marks)**

b. Consider a LTI system with input $x[n]$ and unit impulse response $h[n]$ given below. Compute and plot the output signal $y[n]$ $x[n] = 2^n u(-n)$ $h[n] = u[n]$. **(10 Marks)**

Module-3

5 a. Consider the interconnection of LTI systems depicted in Fig Q5(a). The impulse response of each system is given as $h_1[n] = u[n]$, $h_2[n] = u[n+2] - u[n]$, $h_3[n] = \delta[n - 2]$, $h_4[n] = \alpha^n u[n]$. Find the overall impulse response of the system.
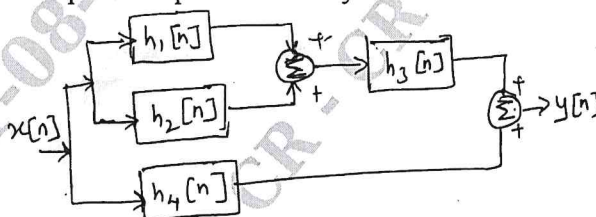

Fig Q5(a) **(06 Marks)**

b. Determine whether the following system defined by their impulse response are memoryless, causal and stable. Justify your answer.

   i) $h(t) = e^t u(-1 - t)$ ii) $h[n] = \text{Cos}(n) u[n]$. **(06 Marks)**

c. A continuous time LTI system has step response $s(t) = e^{-t}u(t)$. Find and sketch the output of the system to the input $x(t)$ shown in Fig Q5(c).
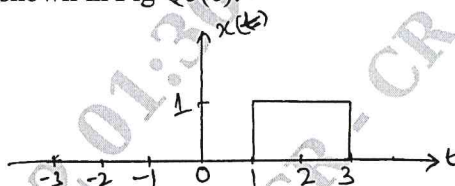

Fig Q5(c) **(08 Marks)**

OR

6 a. Determine the DTFS coefficients of $x[n] = \text{Cos}\left(\dfrac{6\pi}{13}n + \dfrac{\pi}{6}\right)$ and draw the magnitude spectrum and phase spectrum. **(10 Marks)**

b. State the following properties of CTFS. i) Linearity ii) Time shift iii) Frequency shift iv) Scaling v) Time Differentiation vi) Convolution. **(10 Marks)**

Module-4

7 a. State and prove the following properties

   i) $-jtx(t)\xleftrightarrow{\text{FT}}\dfrac{d\,x(w)}{dw}$ ii) $\displaystyle\int_{-\infty}^{\infty}|x(t)|^2\,dt = \dfrac{1}{2\pi}\int_{-\infty}^{\infty}|x(jw)|^2\,dw$ **(10 Marks)**

b. The output $x(t)$ of an ideal low pass filter which has cut off frequency $w_c = 1000\pi$ rad/sec in impulse sampled with the following sampling periods i)$T_s = 0.5 \times 10^{-3}$ ii) $T_s = 2 \times 10^{-3}$ iii) $T_s = 10^{-4}$. Which of these sampling periods would guarantee that $x(t)$ can be recovered from its sampled version. **(05 Marks)**

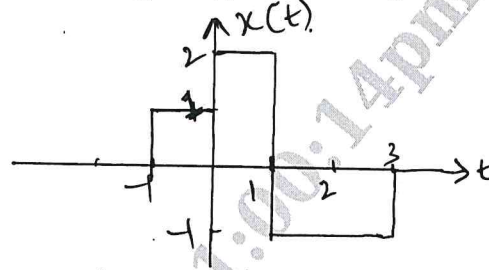c. Find the Fourier Transform for the signal x(t) shown in Fig Q7(c).

Fig Q7(c)   **(05 Marks)**

OR

8 a. Find the DTFT of the following signals

i) $x[n] = 2^n u[-n]$ ii) $x[n] = \sin\left(\dfrac{\pi}{4}n\right)\left(\dfrac{1}{4}\right)^n u(n-1)$ **(10 Marks)**

b. Determine the time domain signals corresponding to the following FT's

i) $x(jw) = e^{-|w|}$ ii) $x(jw) = \left(\dfrac{2jw+1}{(jw+2)^2}\right)$ **(10 Marks)**

Module-5

9 a. State and prove Time Reversal and Differentiation in the z-domain property of Z-Transforms.   **(10 Marks)**

b. Find the inverse Z-transform of

i) $x(z) = \dfrac{z^2 - 3z}{z^2 + \dfrac{3}{2}z - 1}$ $\dfrac{1}{2} < |z| < 2$ ii) $x(z) = \dfrac{8z^2 + 4z}{4z^2 - 4z + 1}$ $|z| > \dfrac{1}{2}$.   **(10 Marks)**

OR

10 a. Use properties of z-transform to compute x(z) of

i) $x(n) = n \sin\left(\dfrac{\pi}{2}n\right)u(-n)$ ii) $x(n) = n^2\left(\dfrac{1}{2}\right)^n u(n-3)$ **(12 Marks)**

b. Determine the transfer function and the impulse response for the causal LTI system if

$x(n) = \delta(n) + \dfrac{1}{4}\delta(n-1) - \dfrac{1}{8}\delta(n-2)$ and $y(n) = \delta(n) - \dfrac{3}{4}\delta(n-1)$.   **(08 Marks)**

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