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10EC44

Fourth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Signals and Systems

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Categorize the following signal as energy or power signal, and find the corresponding energy or power of the signal. $x(t) = \cos(\pi t) + \sin(5\pi t)$. **(06 Marks)**

b. For x(n) and y(n) shown in Fig.Q1(b), draw $x(n+1)\cdot y(-2-n)$. **(06 Marks)**

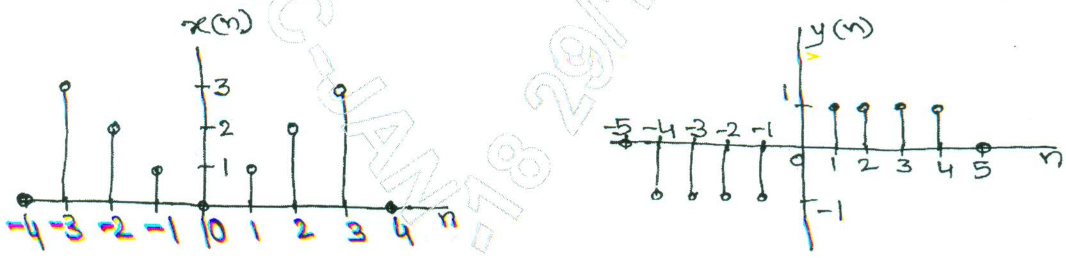

Fig.Q1(b)

c. Determine whether the following signal is periodic or not. If periodic, find its fundamental period. $x(n) = \cos\left(\frac{\pi n}{3}\right)\cdot\sin\left(\frac{\pi n}{5}\right)$. **(04 Marks)**

d. Determine whether the system described by the following input output relation is time – invariant or not $y(t) = \frac{1}{L}\int_{-\infty}^{t} x(\tau)d\tau$. **(04 Marks)**

2 a. The impulse response of a discrete time LTI system is given by $h(n) = a^n[u(n) - u(n-5)]$. Determine the output of the system for the input $x(n) = b^n u(n)$, using convolution sum. **(06 Marks)**

b. Evaluate the continuous time Convolution of the two signals given in Fig.Q2(b). **(06 Marks)**

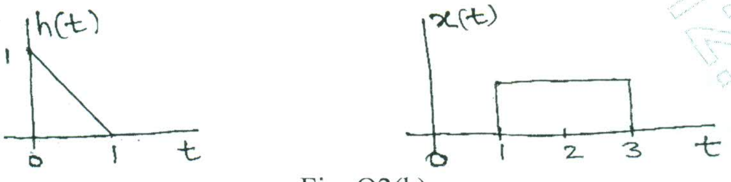

Fig. Q2(b)

c. Compute the discrete time convolution sum of the following two sequences using any method $x_1(n) = \left\{1, \underset{\uparrow}{2}, 3, 4\right\}, x_2(n) = \left\{1, 1, \underset{\uparrow}{3}, 2\right\}$. **(04 Marks)**

d. The impulse response of a continuous time LTI system is given by $h(t) = e^{2t}u(t-1)$. Is the system causal and stable? Give reason for your answer. **(04 Marks)**

3 a. Find the forced response of the system shown in Fig.Q3(a), where $x(t) = \cos(t)$. **(06 Marks)**

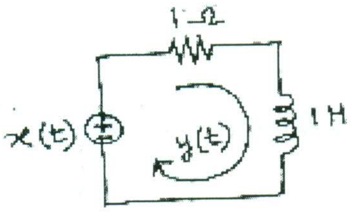

Fig.Q3(a)

b. Draw the direct form I and direct form II implementations of the system described by the following differential equation : $\frac{d^3}{dt^3}y(t) + 2\frac{d}{dt}y(t) + 3y(t) = x(t) + 3\frac{d}{dt}x(t)$. **(06 Marks)**

c. What is the natural response of the system described by the given difference equation? $y(n) - \frac{1}{16}y(n-1) = x(n-1)$, with $y(-1) = 1$. **(04 Marks)**

d. For the interconnections of the system shown in Fig.Q3(d), obtain the overall impulse response in terms of the individual impulse responses. **(04 Marks)**

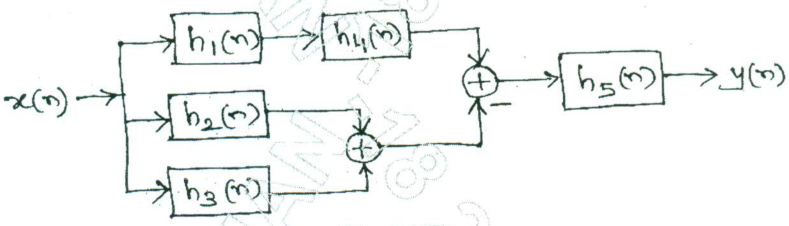

Fig.Q3(d)

4 a. A periodic signal with period 4 sec is described over one fundamental period as $x(t) = 3 - t$, $0 < t < 4$. Find the exponential Fourier series and plot its magnitude spectrum. **(06 Marks)**

b. Determine the discrete time Fourier series representation of the given signal. Draw its magnitude and phase spectra. $x(n) = \cos\left(\frac{6\pi n}{13} + \frac{\pi}{6}\right)$ **(06 Marks)**

c. State and prove frequency shift property with reference to Fourier series of continuous time signals. **(04 Marks)**

d. State and prove Parseval's theorem with reference to DTFS. **(04 Marks)**

PART – B

5 a. Find the inverse Fourier transform and draw the time domain signal for the rectangular spectrum given by $X(j\omega) = \begin{cases} 1, & \frac{-W}{2} < \omega < \frac{W}{2} \\ 0, & |W| > \frac{W}{2} \end{cases}$. **(08 Marks)**

b. A discrete time rectangular pulse is defined as $x(n) = \begin{cases} 1, & |n| \le M \\ 0, & |n| > M \end{cases}$.

Find and plot the DTFT of the signal. **(08 Marks)**

c. Using suitable properties find the inverse DTFT of :

$X(j\Omega) = \frac{1}{1 - ae^{-j(\Omega + \pi/4)}}$, $|a| < 1$. **(04 Marks)**

6 a. A continuous time LTI system produces an output $y(t) = e^{-t}u(t)$ when excited by the input $x(t) = e^{-2t}u(t)$. Evaluate the frequency response and impulse response of the system. **(08 Marks)**

b. Find the impulse response and step response of the LTI system shown in Fig.Q6(b) using Fourier analysis techniques. **(08 Marks)**

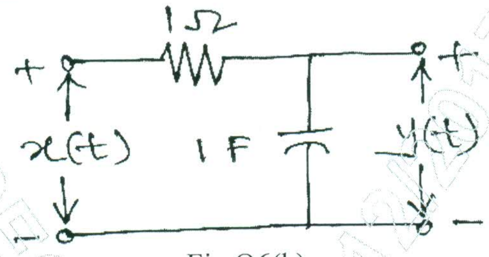

Fig.Q6(b)

c. A continuous time signal is given by $x(t) = 4\cos(100\pi t)$. What is the minimum sampling rate required to avoid aliasing? If the signal is sampled at 200 Hz, then give the expression for the discrete time signal after sampling. **(04 Marks)**

7 a. Using the Z – transform properties, find the Z – transform and RoC of the following signal : $x(n) = n\left(\frac{1}{2}\right)^n u(n) * \left(\frac{1}{4}\right)^{-n} u(-n)$. **(08 Marks)**

b. Find the time domain signal corresponding to the given z – transform, using partial fraction expansion approach. $X(z) = \dfrac{z^3 - 10z^2 - 4z + 4}{2z^2 - 2z - 4}$, RoC : $|z| < 1$. **(08 Marks)**

c. Derive the relation between z – transform and discrete time Fourier transform. **(04 Marks)**

8 a. Consider a system described by the difference equation $y(n) - 0.9\,y(n-1) = x(n)$, with initial condition $y(-1) = 2$. Find the step response of the system using unilateral z – transform. **(08 Marks)**

b. The difference equation of a causal and stable system is given by :

$$y(n) - \frac{5}{6}y(n-1) + \frac{1}{6}y(n-2) = x(n) - 2x(n-1)$$

Determine the impulse response of the system. Also find the output if the input is $x(n) = 2^n u(n)$. **(08 Marks)**

c. Determine the transfer function of the inverse of the system, whose difference equation is given by : $y(n) - \frac{1}{4}y(n-2) = 6x(n) - 7x(n-1) + 3x(n-2)$. **(04 Marks)**

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