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06EC44

Fourth Semester B.E. Degree Examination, June/July 2011

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. Find and sketch the following signals and their derivatives:
i) $x(t) = u(t) - u(t-a)$; $a > 0$ ii) $y(t) = t[u(t) - u(t-a)]$; $a > 0$. **(06 Marks)**

b. Given the signal $x[n] = (8-n)\{u[n] - u[n-8]\}$, determine and sketch :
i) $y_1[n] = x[4-n]$ ii) $y_2[n] = x[2n-3]$. **(04 Marks)**

c. Determine whether the following signals are energy or power signals. Find the corresponding energy or power associated with the signal.
i) $x[n] = (1/4)^n u[n]$ ii) $x[n] = u[n]$ **(04 Marks)**

d. Fig.Q1(d)(i) shows a staircase like signal x(t) that may be viewed as a superposition of four rectangular pulses. Starting with the rectangular pulse shown in Fig.Q1(d)(ii), construct the waveform and express x(t) in terms of g(t). **(06 Marks)**

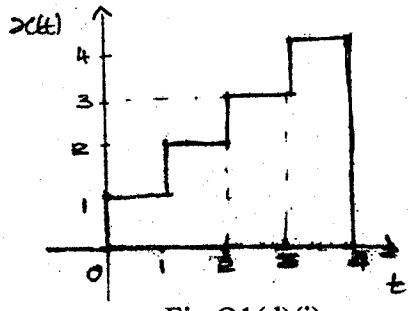

Fig.Q1(d)(i)

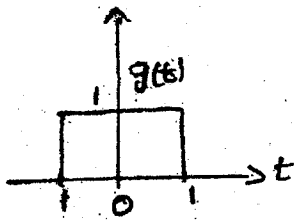

Fig.Q1(d)(ii)

2 a. Show that : i) $x(t) * h(t) = h(t) * x(t)$
ii) $\{x[n] * h_1[n] * h_2[n] = x[n] * \{h_1[n] * h_2[n]\}$ **(06 Marks)**

b. Given $x(t) = u(t) - u(t-3)$ and $h(t) = u(t) - u(t-2)$, evaluate and sketch $y(t) = x(t) * h(t)$. **(06 Marks)**

c. A LTI system has the impulse response given by $h[n] = u[n] - u[n-10]$. Determine the output of the system when the input is $x[n] = u[n-2] - u[n-7]$ using the convolution sum. Show the details of your computation. Sketch all the sequence. **(08 Marks)**

3 a. A discrete LTI system is characterized by the unit sample response $h[n] = \frac{1}{2}\delta[n] + \delta[n-1] + \frac{1}{2}\delta[n-2]$. Determine :
i) Frequency response $H(e^{j\Omega})$ and plot the magnitude component
ii) Steady state response of the system for the input $x[n] = 5\cos\frac{\pi n}{4}$
iii) Total response of the system for the input x[n] = u[n] assuming that the system is initially at rest. **(10 Marks)**

b. Determine whether the system described by the following are stable or causal:
i) $h[n] = (1/2)^n u[n]$ ii) $h(t) = e^t u(-1-t)$ **(06 Marks)**

3 c. Determine the differential equation representation for the block diagram shown in Fig.Q3(c). **(04 Marks)**

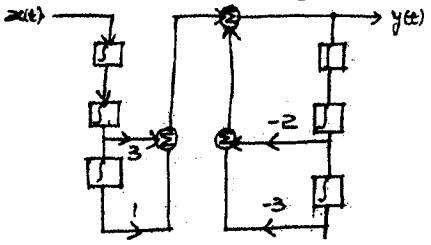

Fig.Q3(c)

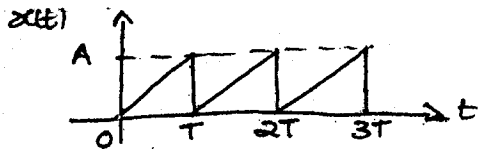

Fig.Q4(b)

4 a. Evaluate the DTFS representation for the signal $x[n]=\sin\left(\frac{4\pi}{21}n\right)+\cos\left(\frac{10\pi}{21}n\right)+1$. Sketch the magnitude and phase spectra. **(08 Marks)**

b. Find the exponential Fourier series of the waveform shown in Fig.Q4(b). **(08 Marks)**

c. Explain the orthogonality of complex sinusoidal signals. **(04 Marks)**

PART – B

5 a. Find the DTFT of the signal $x[n]=n(1/2)^{|n|}$. **(07 Marks)**

b. Determine the signal x[n] if its spectrum is shown in Fig.Q5(b). **(07 Marks)**

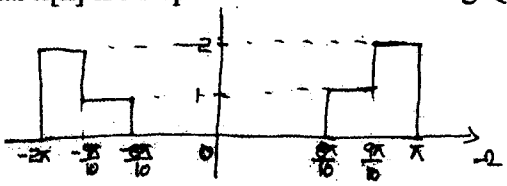

Fig.Q5(b)

c. Determine the Fourier transform of the following signals :

i) $x(t)=e^{-3t}u(t-1)$ ii) $x(t)=e^{-a|t|}$ **(06 Marks)**

6 a. Find the frequency response and impulse response of the system described by the differential equation : $\frac{d^2}{dt^2}y(t)+3\frac{dy(t)}{dt}+2y(t)=2\frac{d}{dt}x(t)+x(t)$. **(08 Marks)**

b. The output of a system in response to an input $x(t)=e^{-2t}u(t)$ is $y(t)=e^{-t}u(t)$. Find the frequency response and the impulse response of this system. **(08 Marks)**

c. Obtain an expression for the Fourier transform in terms of DTFT. **(04 Marks)**

7 a. Find the z-transform of the following and indicate the region of convergence : **(12 Marks)**

i) $x[n]=\alpha^{|n|}$; $0<|\alpha|<1$; ii) $x[n]=2^n\sin\Omega_0(n-2)u(n-2)$; iii) $x[n]=n(n-1)a^nu[n]$

b. Find the inverse z transform of the following :

i) $X(z)=\frac{z^4+z^2}{z^2-\frac{3}{4}z+\frac{1}{8}}$; $|z|>\frac{1}{2}$ ii) $X(z)=\frac{1-az^{-1}}{z^{-1}-a}$; $|z|>\frac{1}{a}$ **(08 Marks)**

8 a. A discrete LTI system is characterized by the difference equation $y[n]=y[n-1]+y[n-2]+x[n-1]$. Find the system function H(z). Plot the poles and zeros of H(z) and indicate the ROC if the system is (i) stable, (ii) causal. Also determine the unit sample response of the stable system. **(09 Marks)**

b. Solve the following difference equation using the unilateral z transform :

$x[n-2]-9x[n-1]+18x[n]=0$ with the initial conditions $x[-1]=1$ and $x[-2]=9$. **(07 Marks)**

c. A system is described by the difference equation :

$$y[n]-y[n-1]+\frac{1}{4}y[n-2]=x[n]+\frac{1}{4}x[n-1]-\frac{1}{8}x[n-2].$$

Find the transfer function of the inverse system. Does a stable and causal inverse system crust? **(04 Marks)**

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