Fourth Semester B.E. Degree Examination, December 2010

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. Distinguish between : i) Periodic and non-periodic signals and ii) Deterministic and random signals. **(04 Marks)**

b. A signal x(t) is as shown in figure Q1 (b). Find its even and odd parts. **(06 Marks)**

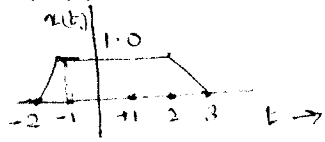

Fig. Q1 (b)

c. Two signals x(t) and g(t) are as shown in figure Q1 (c). Express the signals x(t) in terms of g(t). **(06 Marks)**

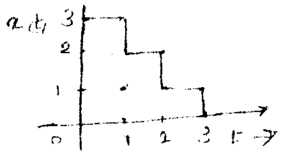

Fig. Q1 (c) – (i)

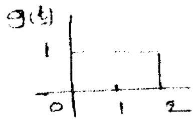

Fig. Q1 (c) – (ii)

d. A system is described by $y(n) = (n+1)x(n)$. Test the system for (i) memory less (ii) Causality (iii) Linearity (iv) Time invariance and (v) Stability. **(04 Marks)**

2 a. An LTI system has impulse response $h(n) = [U(n) - U(n-4)]$. Find the output of the system if the input $x(n) = [U(n+10) - 2U(n+5) + U(n-6)]$. Sketch the output. **(08 Marks)**

b. Show that an aribitrary signal x(n) can be expressed as a sum of weighted and time shifted impulses, $x(n) = \sum_{K=-\infty}^{\infty} x(k)\delta(n-k)$. **(04 Marks)**

c. An LTI system is described by an impulse response $h(t) = [U(t-1) - U(t-2)]$. Find the output of the system if the input x(t) is as shown in figure Q2 (c). Sketch the output. **(08 Marks)**

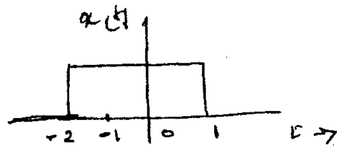

Fig. Q2 (c)

3 a. Two LTI systems with impulse responses $h_1(n)$ and $h_2(n)$ are connected in cascade. Derive the expression for the impulse response if the two systems are replaced by a single system. **(04 Marks)**

b. An LTI system has its impulse response, $h(n) = 4^{-n}U(2-n)$. Determine whether the system is memory less, stable and causal. **(04 Marks)**

c. A system is described by a differential equation,

$\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 2y(t) = x(t) + \frac{dx(t)}{dt}$. Determine its forced response if the input $x(t) = [\cos t + \sin t]U(t)$ **(06 Marks)**

3 d. Draw the direct form I and direct form II implementations for the following difference equation, $y(n)+\frac{1}{2}y(n-1)-y(n-3)=3x(n-1)+2x(n-2)$. **(06 Marks)**

4 a. State and prove convolution property of continuous time Fourier series. **(06 Marks)**

b. Find the DTFS co-efficients of the signal shown in figure Q4 (b), **(08 Marks)**

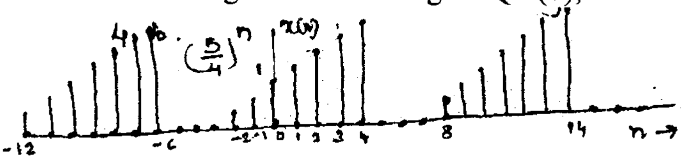

Fig. Q4 (b)

c. Determine the time domain signal x(t), whose Fourier co-efficient are,

$X(K)=\frac{3}{2}e^{\frac{-J\pi}{4}}, K=-1$; $X(K)=\frac{3}{2}e^{\frac{J\pi}{4}}, K=1$; $X(K)=0$ otherwise. **(06 Marks)**

PART - B

5 a. State and prove the following properties of Fourier transform:

i) Frequency shifting property ii) Time differentiation property **(06 Marks)**

b. Show that the Fourier transform of a train of impulses of unit height separated by T secs is also a train of impulses of height $\omega_0=\frac{2\pi}{T}$ separated by $\omega_0=\frac{2\pi}{T}$ sec. **(08 Marks)**

c. Find the DTFT of following signals and draw its magnitude spectrum:

i) $x(n)=a^n U(n)$; $|a|<1$ ii) $x(n)=\delta(n)$ unit impulse. **(06 Marks)**

6 a. The system produces an output $y(t)=e^{-t}u(t)$ for an input of $x(t)=e^{-2t}u(t)$. Determine the frequency response and impulse response of the system. **(08 Marks)**

b. State and prove sampling theorem for low pass signals. **(07 Marks)**

c. Find the Nyquist rate for the following signals:

i) $x(t)=25e^{J500\pi t}$ ii) $[x(t)]=[1+0.1\sin(200\pi t)]\cos(2000\pi t)$ **(05 Marks)**

7 a. State and prove time reversal and differentiation in Z-domain properties of Z-transforms. **(06 Marks)**

b. Find the Z-transforms of following sequences including R.O.C.: i) $x(n)=-\left(\frac{1}{2}\right)^n u(-n-1)$

ii) $x(n)=\alpha^{|n|}$ $|\alpha|<1$ **(06 Marks)**

c. The Z-transform of sequence x(n) is given by, $X(z)=\frac{z(z^2-4z+5)}{(z-3)(z-2)(z-1)}$

Find x(n) for the following ROC's:

i) $2<|z|<3$ ii) $|z|>3$ iii) $|z|<1$. **(08 Marks)**

8 a. Solve the following linear constant co-efficient difference equation using z-transform method: $y(n)-\frac{3}{2}y(n-1)+\frac{1}{2}y(n-2)=\left(\frac{1}{4}\right)^n u(n)$ with initial conditions, $y(-1)=4$, $y(-2)=10$. **(10 Marks)**

b. A causal system has input x(n) and output y(n). Find the impulse response of the system if,

$x(n)=\delta(n)+\frac{1}{4}\delta(n-1)-\frac{1}{8}\delta(n-2)$; $y(n)=\delta(n)-\frac{3}{4}\delta(n-1)$

Find the output of the system if the input is $\left(\frac{1}{2}\right)^n u(n)$. **(10 Marks)**

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