USN | | | | | | | | | | | **10EC44**

Fourth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Signals and Systems

Time: 3 hrs.   Max. Marks: 100

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

PART – A

1 a. Determine and sketch the even and odd parts of the signal show in Fig.Q.1(a). **(05 Marks)**

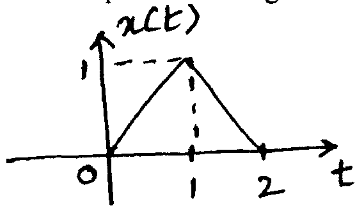

Fig.Q.1(a)

b. Sketch the waveforms of the following signals:
   i) $x(t) = u(t+1) - 2u(t) + u(t-1)$
   ii) $y(t) = r(t+1) - r(t) + r(t-2)$
   iii) $z(t) = -u(t+3) + 2u(t+1) - 2u(t-1) + u(t-3)$. **(09 Marks)**

c. For the following system, determine whether the system is: i) Memoryless; ii) Stable; iii) Causal; iv) Linear; v) Time-invariant.
   $y(n) = 2x(n)\,u(n)$. **(06 Marks)**

2 a. Derive the equation for convolution sum. **(05 Marks)**

b. Evaluate the discrete time convolution sum of
   $y(n) = (1/2)^n u(n-2) * u(n)$. **(05 Marks)**

c. Convolve the signals x(t) and h(t) shown below in Fig.Q.2(c). **(06 Marks)**

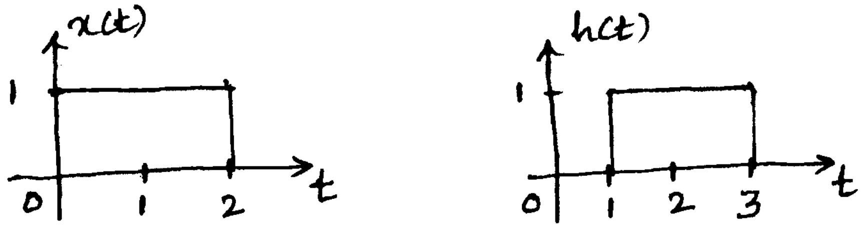

Fig.Q.2(c)

d. Convolve $x(n) = \{1, 2, \underset{\uparrow}{-1}, 1\}$ and $h(n) = \{1, \underset{\uparrow}{0}, 1\}$. **(04 Marks)**

3 a. Find the output, given the input and initial conditions, for the system described by the following differential equation:
   $x(t) = e^{-t} u(t)$, $y(0) = -1/2$, $y'(0) = 1/2$, $y''(t) + 5y'(t) + 6y(t) = x(t)$. **(07 Marks)**

b. Determine the forced response for the system described by the following difference equation and the specified input: $x(n) = 2u(n)$, $y(n) - \frac{9}{16}y(n-2) = x(n-1)$. **(07 Marks)**

c. Draw direct form-I and direct form-II implementations of the system described by the difference equation: $y(n) + \frac{1}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) + x(n-1)$. **(06 Marks)**

4 a. Prove the time shift and frequency shift properties of DTFs. **(06 Marks)**

b. Determine the DTFS of the signal

$$x(n) = \cos\left(\frac{\pi}{3}\right)n .$$ **(06 Marks)**

c. Evaluate the Fourier series representation of the signal x(t) = Sin 2πt + cos 3πt. Also sketch the magnitude and phase spectra. **(08 Marks)**

PART – B

5 a. Prove the convolution property of DTFT. **(05 Marks)**

b. Find the DTFT of unit step sequence. **(07 Marks)**

c. Compute the Fourier transform of the signal

$$x(t) = \begin{cases} 1 + \cos \pi t; & |t| \le 1 \\ 0; & |t| > 1 \end{cases} .$$ **(08 Marks)**

6 a. The impulse response of a continuous time system is given by

$$h(t) = \frac{1}{RC} e^{-t/RC} u(t) .$$

Find the frequency response and plot the magnitude and phase response. **(05 Marks)**

b. Obtain the FT representation for the periodic signal $\sin w_0 t$ and draw the spectrum. **(07 Marks)**

c. Find the DTFT representation for the periodic signal

$$x(n) = \cos\left(\frac{\pi}{3}\right)n$$

Also draw the spectrum. **(05 Marks)**

d. Write a note on sampling theorem and Nyquist rate. **(03 Marks)**

7 a. List the properties of region of convergence. **(05 Marks)**

b. Determine the Z-transform, the ROC, and the locations of poles and zeros of x(z) for the following signals: **(08 Marks)**

i) $x(n) = -\left(\frac{3}{4}\right)^n u(-n-1) + \left(\frac{-1}{3}\right)^n u(n)$ ii) $x(n) = n \sin\left(\frac{\pi}{2} n\right) u(-n)$.

c. Find the inverse Z-transform of

$$X(z) = \frac{1 - z^{-1} + z^{-2}}{\left(1 - \frac{1}{2} z^{-1}\right)\left(1 - 2z^{-1}\right)\left(1 - z^{-1}\right)}$$

with following ROCs i) $1 < |z| < 2$ ii) $\frac{1}{2} < |z| < 1$. **(07 Marks)**

8 a. Find the transfer function and impulse response of a causal LTI system if the input to the system is $x(n) = (-1/3)^n u(n)$ and the output is $y(n) = 3(-1)^n u(n) + (1/3)^n u(n)$. **(08 Marks)**

b. Determine the transfer function and difference equation representation of an LTI system described by the impulse response $h(n) = (1/3)^n u(n) + (1/2)^{n-2} u(n-1)$. **(04 Marks)**

c. Determine the forced response, natural response and output of the system described by the difference equation $y(n) + 3y(n-1) = x(n) + x(n-1)$, if the input is $x(n) = \left(\frac{1}{2}\right)^n u(n)$ and y(-1) = 2 is the initial condition. **(08 Marks)**

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