Final Assessment Test – November 2019

VIT
Vellore Institute of Technology

Course: ECE1018 - Signal Analysis and Processing

Class NBR(s): 1099 / 6827 Slot: A1

Time: Three Hours Max. Marks: 100

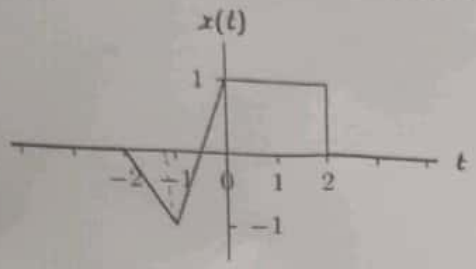
KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS EXAM MALPRACTICE

Answer ALL Questions

(100 Marks)

1. a) Consider a continuous-time system with input $x(t)$ and output $y(t)$ related by $y(t) = x(\sin(t))$. [5]
   i) Is this system causal?
   ii) Is this system linear?

   b) Let $x(t)$ represent the signal as shown below [5]



Determine all values

i) for which $y(t) = 1$, if $y(t) = x(2t+3)$

ii) Assume that $x(t)$ can be written as the sum of an even part. For what values of t, $x_e(t) = 0$?

2. Given $x(t) = \begin{cases} 1, & 0 \le t \le 1 \\ 0, & \text{otherwise} \end{cases}$ and $h(t) = x(t/a)$ where $0 \le a \le 1$ [10]

a) Determine and sketch $y(t) = x(t) * h(t)$

b) if dy/dt contains only 3 discontinuities, what is the value of a?

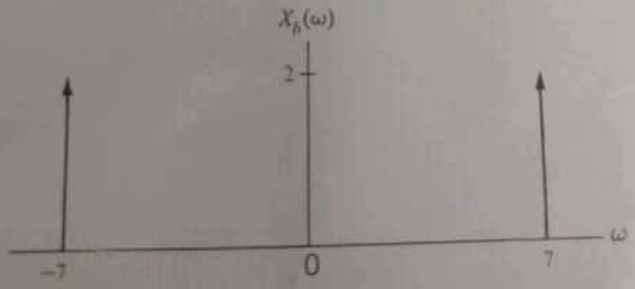
3. a) Find the complex CTFS harmonic function of $x(t) = A\,rect(t/w) * \delta_{T_0}(t), w < T_0$ using its fundamental period of time as representation. [5]

   b) Consider the signal $x[n] = 1 + \sin\left(\frac{2\pi}{N}\right)n + \cos\left(\frac{2\pi}{N}\right)n + \cos\left(\frac{4\pi}{N} + \frac{\pi}{2}\right)n$ [5]

   Find the Fourier series coefficients

4.(a) Find the signal corresponding to the following Fourier transforms. [10]

i. $X_a(\omega) = \dfrac{1}{7 + j\omega}$



ii.

iii. Find $x_d(t) = x_a(t) * x_b(t)$

OR

4.(b) The noncausal signal $x(t) = e^{-3t}u(t) + e^{-t}u(-t)$ is the excitation of a noncausal highpass filter whose impulse response is $h(t) = \delta(t) - e^{-2|t|}$. Find the response of the system $y(t)$. [10]

5. Determine the impulse response $h[n]$ by assuming the following conditions. [10]

a) Input, $x[n] = \left(\frac{1}{4}\right)^n u[n]$ and
Output $g[n] = 0$ for $n \geq 2$ and $n < 0$

b) $H(e^{j\pi/2}) = 1$

c) $H(e^{j\omega}) = H(e^{j(\omega-\pi)})$

6. a) Find the autocorrelation function of $x(t) = e^{-6t}u(t)$ [5]

b) Verify that autocorrelation and energy spectral density are Fourier transform pairs. [5]

7. a) Find the initial and final values of [5]

$$X(s) = \frac{6s^3 + 2s + 5}{s(s+2)^2(s+3)}$$

b) Solve the initial value problem [5]
$y'' - 4y' + 9y = t,\ y(0) = 0,\ y'(0) = 1$

8.(a) Find the inverse Laplace transform of [10]

$$X(s) = \frac{10s^2 + 4}{s(s+1)(s+2)^2}$$

OR

8.(b) Determine the inverse Laplace transform of the following [4]

i) $X(s) = 1 + \frac{3}{s+4} - \frac{5s}{s^2+25}$

ii) $X(s) = \frac{4 - e^{-2s}}{s^2 + 5s + 4}$ [6]

9. a) Find the z-transform depicting ROC of [5]
$x(n) = a^{-n}u[-n-1]$

b) Find the inverse z-transform of [5]
$X(z) = \frac{3}{z-2},\ |z| > 2$

10. a) Find the inverse z-transform of [7]

$$X(z) = log\left(\frac{1}{1-a^{-1}z}\right),\ |z| < |a|$$

b) Determine z-transform and mention the ROC for the finite duration signal [3]
$x[n] = \delta(n-k), k > 0$

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