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 Name of Examination : **Winter 2020** - (Preview)

 Course Code & Course Name : **ET204U - Signals and Systems**

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 Maximum Marks : **60**

 Duration : **3 Hrs**
[Edit](#) [Print](#) [View Answer Key](#) [Close](#) **Answer Key Submission Type:** Marking scheme with model answers and solutions of numerical

Instructions:

1. All questions are compulsory.
2. Illustrate your answer with suitable figures/sketches wherever necessary.
3. Assume suitable additional data; if required.
4. Use of logarithmic table, drawing instruments and non programmable calculators is allowed.
5. Figures to the right indicate full marks.

**1)** Attempt any three sub-questions.

 a) Let  $x[n]$  and  $y[n]$  be the two discrete signals shown in Figure 1.

[6]

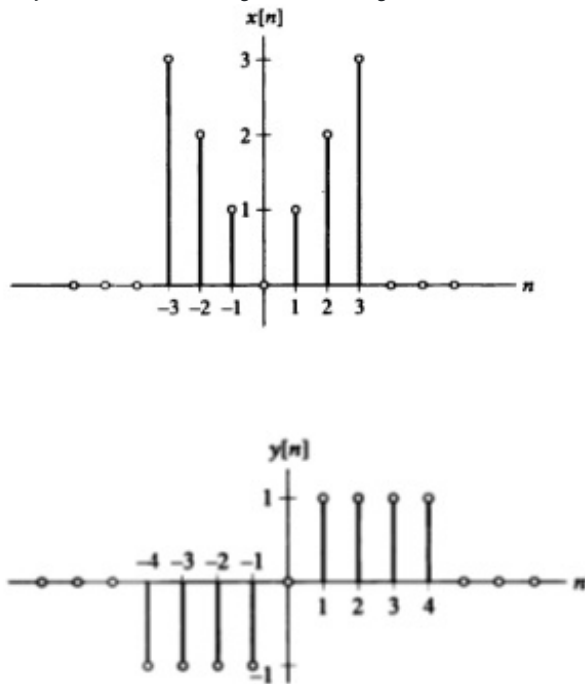


Figure 1

Sketch and label the following signals.

 (i)  $x[2n]$ , (ii)  $y[n-4]$ , (iii)  $y[n]x[3n-1]$ 

b) Categorize the following signal as an energy signal or power signal.

[6]

$$x(t) = \begin{cases} 5 - t, & 4 \leq t \leq 5 \\ 1, & -4 \leq t \leq 4 \\ t + 5 & -5 \leq t \leq -4 \\ 0, & \text{otherwise} \end{cases}$$

c) The input signal and impulse response of an LTI system are given below. Calculate and sketch the output of the system.

[6]

$$x[n] = u[n] \text{ and } y[n] = \alpha^n u[n], \quad |\alpha| < 1$$

d) Determine the response of the LTI system which has the following impulse response and input signal.

[6]

$$h(t) = u(t) - u(t-3) \text{ and } x(t) = u(t) - u(t-3)$$

**2)** Attempt any three sub-questions.

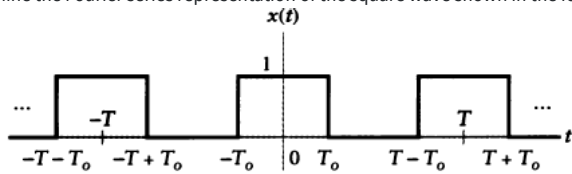
a) State and prove the following properties of the Fourier transform.

[6]

i) Time shifting

ii) Differentiation in frequency domain

b) Determine the Fourier series representation of the square wave shown in the following Figure. [6]



c) Find the Fourier transform of  $x(t) = e^{-at}u(t)$  [6]

Assume  $a > 0$ . Also, sketch the magnitude spectrum and phase spectrum.

d) Find the inverse Laplace transform of [6]

$$X(s) = \frac{-5s-7}{s^3+2s^2-s-1}, \text{ with } RoC -1 < Re(s) < 1$$

3) Attempt any three sub-questions. [6]

a) Solve the following differential equation using the unilateral Laplace transform. [6]

$$y''(t) + 5y'(t) + 6y(t) = x'(t) + 6x(t)$$

Consider the input signal  $x(t)=u(t)$ . Assume that initial conditions are  $y(0) = 1$  and  $y'(0) = 2$ .

b) Find the Laplace transform of [6]

$$x(t) = \frac{d^2}{dt^2} (e^{-3(t-2)}u(t-2)). \text{ Also, sketch the region of convergence for the same.}$$

c) The sinusoidal signal  $x(t) = 3 \cos(200\pi t + \frac{\pi}{6})$  is passed through a system described by the following equation. [6]

$$y(t) = x^2(t)$$

Show that output contains a dc component and sinusoidal component. Specify amplitude and fundamental frequency of sinusoidal component. Classify this system for linearity and time invariance.

d) Find the frequency response and impulse response of the system having output  $y(t)$  for the input  $x(t)$ , as given below. [6]

$$x(t) = e^{-2t}u(t) \text{ and } y(t) = e^{-t}u(t)$$

4) Compute and sketch autocorrelation function of the following signal. [6]

$$x[n] = \left(\frac{1}{2}\right)^n \{u[n] - u[n-4]\}.$$

Hence determine energy of the signal  $x[n]$ .

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