BETCE EXAMINATION, 2023
(2nd Year 1st Semester)
Signals and Systems

Full Marks: 100 **Time: 3 hours**

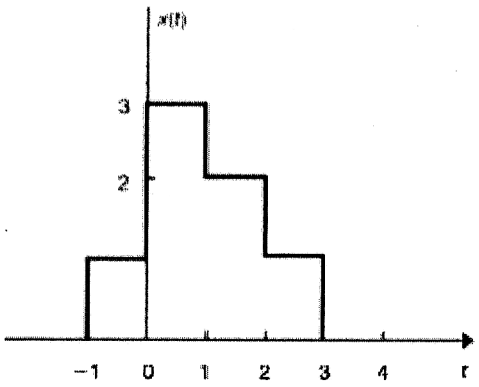
Answer all parts & subparts of a question under a unit serially in the same place

UNIT-1 (Marks: 25)

Q1. a) Sketch the signal x(t) = r(t) - r(t-1) - u(t-1) + r(t-2) - r(t-3) - u(t-3) where r(t) and u(t) represents unit ramp and unit step function respectively. [5]

b) Check whether the given signal x(t) = t u(t) is energy or power signal. [5]

c) Express the given signal x(t) in terms of unit step functions. [5]



OR

Q1. a) find whether the given signal x(t) is periodic or not. If periodic, find the time period of the signal.

x(t) = cos[(1/3)t] + sin[(1/4)t] [5]

b) Find even and odd components of the signal x(t) = cost + sint + cost sint [5]

c) Differentiate between Orthogonal and Orthonormal signal set. State the condition under which an Orthogonal set is said to be complete. [4+1]

Q2.a) Prove that time domain convolution between two signals leads to frequency domain multiplication. [6]

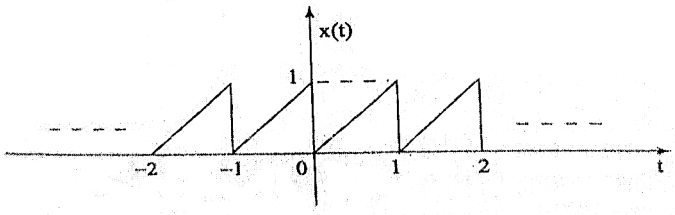
b) Discuss in brief, the significance of the following terms: [2+2]

i) Essential Bandwidth of a signal

ii) Correlation coefficient between two signals

UNIT-2 (Marks: 15)

Q3. Find the Exponential Fourier Series for the periodic signal x(t). Hence plot the magnitude and phase spectrum of x(t). [9+6]



OR

Q3. a) Find the Fourier Transform of the following signal: [5]

$x(t) = (1/2)\,[\delta(t + 1) + \delta(t + 0.5) + \delta(t - 0.5) + \delta(t - 1)]$

b) Explain the significance of Time Shifting property of Fourier Transform. [4]

c) The Exponential Fourier Series representation of a signal x(t) over the interval (0,T) is

$x(t) = \sum_{n=-\infty}^{\infty} [\frac{3}{4} + (n\pi)^2]\, e^{jn\pi t}$ [3+3]

i) What is the numerical value of T?

ii) One of the components of x(t) is $A\cos 3\pi t$. Determine the value of A.

UNIT-3 (Marks: 10)

Q4. It is required to reconstruct a practical signal (time limited) from its samples. Explain the effect of Aliasing and the impact of Anti-aliasing filter on the reconstructed signal through neat sketches and necessary labeling of the following (no description is required): [10]

i) Spectrum of a practical signal

ii) Spectrum of the sampled signal

iii) Reconstructed signal spectrum

Iv) Sampling scheme using Anti-aliasing filter

v) Sampled signal spectrum and the reconstructed signal spectrum after incorporation of Anti-aliasing filter

OR

Q4. a) Draw the waveform of Pulse Position Modulated (PPM) signal considering a sinusoidal message signal and a periodic pulse train as the carrier signal. State one advantage of this kind of modulation. [3+2]

b) The signal $x(t) = \cos 5\pi t + \cos 10\pi t$ is instantaneously sampled. The interval between the samples is T_S. Find the maximum allowable value of T_S. To reconstruct the signal, the sampled signal is passed through a low-pass filter. Find the minimum filter bandwidth to reconstruct the signal without distortion. [5]

UNIT-4 (Marks: 15)

Q5. a) For the discrete-time system $y(n) = 2x(n) + 1/[x(n-1)]$, check whether it is linear/non-linear. Here, x(n) and y(n) represents input and output respectively. [5]

b) Compute convolution of two sequences x(n) and h(n) graphically. Given, $x(n) = \{\underline{1},2,4\}$ and $h(n) = \{\underline{1},1,1,1,1\}$. Underline signifies n=0 position. [10]

UNIT-5 (Marks: 10)

Q6. If f(x) is the PDF of a random variable X defined by

$f(x) = 2(1-x)^2 \quad 0 < x < 1$

$= 0 \qquad$ elsewhere

Find i) $E[6X + 3X^2]$ and ii) variance of 2X+3. [5+5]

OR

Q6. The PDF of a continuous random variable X in the range (-3, 3) is defined as follows:

$= (1/16)\,[3+x]^2 \qquad$ for $-3 \le x \le -1$

$f_X(x) = (1/16)\,[2-6x]^2 \qquad$ for $-1 \le x \le 1$

$= (1/16)\,[3-x]^2 \qquad$ for $1 \le x \le 3$

Verify that the area under the curve is unity. Also prove that the mean is zero. [7+3]

UNIT-6 (Marks: 25)

Q7. Consider that noise is a random process and it can be represented as the superposition of noise spectral components. Also consider that the spectral component associated with the kth frequency interval is given by: [15]

$n_k(t) = a_k \cos(2\pi k\Delta f t) + b_k \sin(2\pi k\Delta f t)$.

Derive the statistical properties of a_k and b_k, where the symbols have their usual meanings.

OR

Q7. a) Derive the expressions for the quadrature components of noise. [8]

b) State the properties of the quadrature components of noise. [2]

c) Discuss the significance of quadrature component representation of noise. [5]

Q8. Consider a cascade of two amplifier stages where A_1 is the gain and R_1 is the total input noise resistance of the first stage; A_2 is the gain and R_2 is the total input noise resistance of the second stage and R_3 is the output resistance. Calculate the equivalent resistance of the cascaded amplifier. Using this knowledge, how can you calculate the noise voltage produced at the output of this cascade? [7+3]

OR

Q8.a) An RC low-pass filter is placed before the demodulator of a communication system to limit noise in the system. Calculate the amount of noise power which is delivered to the demodulator. [7]

b) For low noise level, Noise Temperature is preferred to Noise Figure for the purpose of noise measurement-explain. (No derivation is required). [3]