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**PRESIDENCY UNIVERSITY
BENGALURU**

SET A

**SCHOOL OF ENGINEERING
END TERM EXAMINATION - JAN 2024**

Semester : Semester V - 2021
Course Code : ECE3028
Course Name :Speech Signal Processing
Program : B.Tech.

Date : 05-JAN-2024
Time : 9:30AM - 12:30 PM
Max Marks : 100
Weightage : 50%

Instructions:

- (i) Read all questions carefully and answer accordingly.
- (ii) Question paper consists of 3 parts.
- (iii) Scientific and non-programmable calculator are permitted.
- (iv) Do not write any information on the question paper other than Roll Number.

PART A

ANSWER ALL THE QUESTIONS

5 X 2M = 10M

1. In mathematical physics, the Dirac delta distribution (δ distribution), also known as the unit impulse,[1] is a generalized function or distribution over the real numbers, whose value is zero everywhere except at zero, and whose integral over the entire real line is equal to one. For the sequence $x[n] = \{2, -3, 1, 0, 1, -3, 2\}$, express the signal $x[n]$ as shifted version of impulse (delta) signal.
(CO1) [Knowledge]
2. In electronics, an analog to digital converter (ADC) is a system that converts an analog signal into a digital signal. There are a number of processes to be followed in analog to digital conversion. Explain the term Resolution/Quantization Step-Size (Q).
(CO2) [Knowledge]
3. In signal processing, a filter is a device or process that removes some unwanted components or features from a signal. Define High pass filter with proper diagram of input and output signal.
(CO3) [Knowledge]
4. An impulse function, often called the (Dirac delta function), is defined not by its values but by its behavior in a limit and by its behavior under integration. Ref: Polking et. al. The Dirac delta function provides a model for a force that concentrates a large amount of energy over a short time interval.

For the following sequence draw the graph and express $x[n]$ in terms of shifted delta function

$$x[n] = \{ 2, -1, 0, 3\}$$

(CO3) [Knowledge]

5. An impulse input is a very high pulse applied to a system over a very short time. That is, the magnitude of the input approaches infinity while the time approaches zero. Draw the graph for the following signal $x[n]$ with respect to time 'n'

$$x[n] = 2\delta[n + 2] + \delta[n + 1] + \delta[n] + \delta[n - 1]$$

(CO4) [Knowledge]

PART B

ANSWER ALL THE QUESTIONS

5 X 10M = 50M

6. The speech signal, as it emerges from a speaker's mouth, nose and cheeks, is a one-dimensional function (air pressure) of time. Microphones convert the fluctuating air pressure into electrical signals, voltages or currents, in which form we usually deal with speech signals in speech processing.

For a speech signal having **voltage values in the range of - 4.5 Volt to 9.5 Volt (I have not given any graph as intermediate voltage values are not of our concern)**. Separate the voltage range such that it fits into a 3-bit number. Draw only the table for Discrete Voltage Ranges (V) for the eight output states and the corresponding Output Binary Equivalent.

(CO1) [Comprehension]

7. Resolution is the smallest voltage that can be encoded digitally, in other words the voltage represented by the least significant bit. For a range of -5 to 5V, and a 4-bit resolution, what is the binary value for 4.5V?

(CO2) [Comprehension]

8. Fourier transform (FT) is an integral transform that converts a function into a form that describes the frequencies present in the original function. For the following continuous time signal, find the Fourier Transform expression.

$$x(t) = e^{-at}u(t)$$

(CO3) [Comprehension]

9. Laplace transform is the integral transform of the given derivative function with real variable t to convert into a complex function with variable s. Find the Laplace Transform of the following continuous time signal

$$x(t) = e^{-3t}u(t)$$

(CO3) [Comprehension]

10. Information entropy is the average amount of information conveyed by an event, when considering all possible outcomes. A source emits one of four possible symbols ' X_0 ' to ' X_3 ' during each signalling interval. The symbol occur with probabilities as given in the table below:

Symbol	Probability
X_0	0.45
X_1	0.37
X_2	0.25
X_3	0.17

Find the entropy of the system

(CO4) [Comprehension]

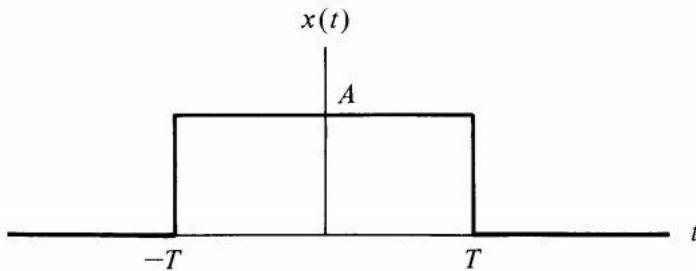
PART C

ANSWER ALL THE QUESTIONS

2 X 20M = 40M

11. The Fourier transform is a type of mathematical function that splits a waveform, which is a time function, into the type of frequencies that it is made of. The result generated by the Fourier transform is always a complex-valued frequency function. For the following rectangular pulse,

- a) find the Fourier Transform expression and
- b) draw the frequency response (Magnitude versus frequency plot)



(CO3) [Application]

12. Shannon Fano Algorithm is an entropy encoding technique for lossless data compression of multimedia. Named after Claude Shannon and Robert Fano, it assigns a code to each symbol based on their probabilities of occurrence. It is a variable-length encoding scheme, that is, the codes assigned to the symbols will be of varying lengths.

Given the following messages with respective probabilities in the table below, construct a binary code by applying Shannon-Fano Encoding procedure. Also determine

- a) Average length of the code
- b) Code Efficiency
- c) Redundancy of the code
- d) Draw the code tree or graph

Symbol	Probability
X_1	0.4
X_2	0.3
X_3	0.2
X_4	0.05
X_5	0.05

(CO4) [Application]