2022

DIGITAL COMMUNICATION SYSTEMS AND STOCHASTIC PROCESS

Full Marks: 100

Time: Three hours

The figures in the margin indicate full marks for the questions.

Answer ***any five*** *questions.*

1.	a)	State the sampling theorem for a low-pass bandlimited signal. Hence show that the spectrum of sampled waveform, in case of impulse sampling, is the repetition of the spectrum of low-pass bandlimited signal.	2+8 = 10
	b)	Calculate the bandwidth required for PCM signal. Show that for each additional bit in the code-word transmitted by a binary PCM in case of sinusoidal message, the output quantization SNR increases by 6 dB.	10
2.	a)	How many types of uniform quantizers are there? Draw the input-output characteristic for such quantizers. Hence show that the average output power in quantization noise is inversely proportional to the square of the number of quantization level (Q).	1+3+6 = 10
	b)	A DM transmitter with a fixed step size of 0.5 V is given a sinusoidal message signal. If the sampling frequency is twenty times the Nyquist rate, find (i) the maximum permissible amplitude of the message signal avoiding slope-overload (ii) the maximum destination SNR.	5+5 = 10
3.	a)	Prove that a 1st order predictor in a DPCM is a unit-delay block.	5
	b)	What is aperture effect in flat-top sampling.	5
	c)	Show that the error probability for digital baseband signalling is given by $P_e = Q\left(\frac{d}{2}\right)$; where 'Q' is the Q-function given by $Q(k) = \frac{1}{\sqrt{2\pi}}\int_k^{\infty} e^{-x^2/2}\,dx$.	10
4.	a)	A baseband binary system transmits the signal $s_1(t)$ for binary '1' and $s_2(t)$ for binary '0', where $s_1(t)=\begin{cases} A\ ; 0\le t\le T/2 \\ A/2\ ;\ T/2\le t\le T \\ 0\ ,\ \textit{elsewhere}\end{cases}$ and $s_2(t)=\begin{cases} A/2\ ; 0\le t\le T/2 \\ -A/2;\ T/2\le t\le T \\ 0\ ,\ \textit{elsewhere.}\end{cases}$	15

		The channel may be assumed to be AWGN with noise PSD of '$N_0/2$' and the symbols are equi-probable. Find the energy of the two transmitted signals and hence find the average energy per bit. Also find the probability of bit error 'P_e'.	
	b)	Explain why polar signals are preferred over uni-polar signals for a given value of input SNR at the front end of a receiver.	5
5.	a)	Show that the BER (average error probability) for a polar NRZ signal using matched filter technique is given by $P_e\big\|_{Polar,NRZ} = Q\left[\sqrt{\frac{2E_b}{\eta}}\right]$; where the symbols have their usual meaning.	10
	b)	Deduce the power spectral density (PSD) for BFSK modulated signal. Hence calculate the transmission bandwidth (B_T) of the BFSK signal.	10
6.	Write short notes on any ***two*** of the following		10 x 2 = 20
	a)	Line codes for binary signal.	
	b)	Detection of BPSK modulated signal.	
	c)	Power spectral density (PSD) for NRZ data.	
	d)	Matched filter.	

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