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06EC61

Sixth Semester B.E. Degree Examination, Dec.2013/Jan.2014
Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. State the sampling theorem for band limited signal. Show that the process of sampling a signal results in a periodic spectrum with a period equal to sampling rate. **(08 Marks)**

b. Derive an expression for the spectrum of flat top samples and explain the signal reconstruction process. **(08 Marks)**

c. The spectrum of a band pass signal occupies a band of width 0.5 kHz, centered around ±10kHz. Find the Nyquist rate for quadrature sampling the in-phase and quadrature components of the signal. **(04 Marks)**

2 a. Prove that the each bit in the codeword of a PCM system contributes 6 dB to the signal to quantization noise ratio. **(06 Marks)**

b. What is robust quantization? With the help of compander transfer characteristics, explain the process of non-uniform quantization. **(08 Marks)**

c. Six independent message sources of bandwidths W, W, 2W, 2W, 3W and 3W hertz are to be transmitted on a time division multiplexed basis using a common communication channel.

(i) Set up a scheme for accomplishing this multiplexing requirement, with each message signal sampled at its Nyquist rate.

(ii) Determine the minimum transmission bandwidth of the channel. **(06 Marks)**

3 a. With a neat block diagram, explain DPCM transmitter and receiver. **(08 Marks)**

b. Consider a random binary sequence where bits are statistically independent and equally likely. Determine the power spectral density for the sequence represented in NRZ unipolar format. **(08 Marks)**

c. Consider a speech signal with maximum frequency of 3.4 kHz and maximum amplitude of 1 Volt. It is applied to a delta modulator whose bit rate is set at 20 kbps. What is the minimum step size required to process the speech signal? **(04 Marks)**

4 a. What is ISI? Obtain the Nyquist criterion for distortionless baseband binary transmission. **(08 Marks)**

b. A computer outputs binary data at the rate of 56 kbps and transmitted using a baseband binary PAM system which is designed to have a raised cosine spectrum. Determine the transmission bandwidth required for each of the following roll off factors:

(i) $\alpha = 0.25$ (ii) $\alpha = 0.5$ (iii) $\alpha = 1.0$ **(08 Marks)**

c. The binary data 001101001 are applied to the input of a duobinary system.

(i) Construct the duobinary coder output and corresponding receiver output, without a precoder.

(ii) Suppose that due to error during transmission the level at the receiver input produced by the second digit is reduced to zero, construct the new receiver output. **(04 Marks)**

PART – B

5 a. Derive an expression for the average probability of symbol error for coherent binary PSK signal. **(08 Marks)**

b. An FSK system transmits binary data at the rate of 2.5×10^6 bits per second. During the course of transmission, white Gaussian noise of zero mean and power spectral density 10^{-20} Watts/Hz is added to the signal. In the absence of noise, the amplitude of the received sinusoidal wave for digit 1 or 0 is 1 microvolt. Determine the average probability of symbol error, assuming coherent detection and the value erf(2.2) = 0.997828. **(08 Marks)**

c. Obtain the differential encoded sequence and the transmitted phase for the binary data 10010011. **(04 Marks)**

6 a. Explain the scheme for generating the signal and its coefficients using Gram-Schmidt orthogonalization procedure. **(10 Marks)**

b. Consider the set of signals

$$S_i(t) = \begin{cases} \sqrt{\frac{2E}{T}}\cos\left(2\pi f_c t + i\frac{\pi}{4}\right) & 0 \le t \le T \\ 0 & \text{elsewhere} \end{cases}$$

where $i > 1, 2, 3, 4$ and $f_c = \frac{u_c}{4}$ for some fixed integer u_c.

(i) What is the dimensionality, N, of the signal set.
(ii) Find a set of orthogonal basis functions to represent this set of signals.
(iii) Determine the coefficients of the signal $S_i(t)$.
(iv) Plot the signal constellation. **(10 Marks)**

7 a. Explain the maximum likelihood detection for an AWGN channel. **(10 Marks)**

b. Consider the signal, $S(t) = \begin{cases} a/2 & 0 \le t \le T/2 \\ -a/2 & T/2 < t \le T \\ 0 & \text{elsewhere} \end{cases}$

(i) Determine the impulse response of a filter matched to S(t).
(ii) Plot the matched filter output.
(iii) Determine the peak value of the output. **(10 Marks)**

8 a. With a neat block diagram, explain the frequency hop spread spectrum transmitter and receiver. **(08 Marks)**

b. A 3-stage shift register with a maximum length sequence of 0011101. Verify the three properties of the PN sequence. **(09 Marks)**

c. A direct sequence spread binary PSK uses a feedback shift register of length 19 for the generation of the PN sequence. Calculate the processing gain of the system. **(03 Marks)**

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