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NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2006

Digital Communication

Time: 3 hrs.] [Max. Marks:100

Note: ***1. Answer any FIVE full questions.***

1 a. With a block diagram explain a typical digital communication system. **(06 Marks)**

b. Explain different channels used in digital communication. **(06 Marks)**

c. State and prove sampling theorem as applied to low pass signal. **(08 Marks)**

2 a. Explain the principle of quadrature sampling of band pass signals. **(06 Marks)**

b. The signal $g(t)=4\cos(4\pi t)\cos(400\pi t)$ is sampled at the rate of 500 samples/sec.
i) Determine the spectrum of the resulting sampled signal.
ii) What is the Nyquist rate for g(t)?
iii) What is the cut off frequency of ideal reconstruction filter? **(08 Marks)**

c. Three independent message sources of bandwidths 1 KHz, 1 KHz, 2 KHz respectively are to be transmitted using TDM scheme. Determine:
i) the commutator segment arrangement.
ii) the speed of commutator if each signal is sampled at its Nyquist rate.
iii) minimum transmission bandwidth. **(06 Marks)**

3 a. Obtain an expression for the signal to quantization noise power ratio in the case of PCM. Assume that the amplitude of signal is uniformly distributed. **(06 Marks)**

b. A speech signal of maximum frequency 3.4 KHz and amplitude 1 V is applied to a delta modulator whose bit rate is 20 Kbps. Determine minimum step size for the delta modulator so that there is no slope overload. **(06 Marks)**

c. With a block diagram explain an adaptive delta modulator transmitter and receiver system. **(08 Marks)**

4 a. A binary data sequence is 0110011... Sketch the waveform for the following formats:
i) NRZ unipolar ii) RZ polar iii) NRZ bipolar iv) Manchester coding.
Discuss the merits and demerits of these formats. **(08 Marks)**

b. Obtain an expression for the power spectral density of NRZ polar waveform. **(06 Marks)**

c. The binary data 001101001 are applied to the input of a duo binary system. Construct the duo binary coder output and corresponding receiver output. Assume that precoder is used. **(06 Marks)**

Contd... 2

5 a. Explain a coherent binary PSK transmitter and receiver. **(06 Marks)**

b. Assuming channel noise to be Additive White Gaussian, obtain an expression for probability of error. **(06 Marks)**

c. Explain the principle of QPSK system. Compare binary PSK and QPSK schemes. **(08 Marks)**

6 a. With block diagram explain the principle of detection and estimation. **(06 Marks)**

b. Give the properties of matched filter. **(06 Marks)**

c. A signal s(t) of duration Tsec is as follows :

$s(t) = +a/2$ for $0 \le t \le T/2$

$= -a/2$ for $T/2 < t \le T$.

i) Determine the impulse response of a filter matched to this signal and sketch it as a function of time.

ii) Plot matched filter output as a function of time.

iii) What is the peak value of the output? **(08 Marks)**

7 a. Explain the sequence of PN sequence. **(06 Marks)**

b. Explain the principle of direct sequence spread spectrum communication system. **(08 Marks)**

c. In a direct sequence spread spectrum system, a 20 – stage feedback shift register is used to generate maximum length PN sequence. What is the processing gain? **(06 Marks)**

8 a. Explain the principle of frequency hopping spread spectrum system. **(08 Marks)**

b. Mention the advantages of spread spectrum communication system. **(06 Marks)**

c. A slow FH/MFSK system has the following parameters:
The number of bits MFSK symbol = 4
The number of MFSK symbols per hop = 6
Calculate the processing gain of the system. **(06 Marks)**

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EC61

Sixth Semester B.E. Degree Examination, Dec. 07 / Jan. 08
Digital Communication

Time: 3 hrs. Max. Marks:100

Note : *1. Answer any FIVE full questions.*
2. Assume missing data suitably.

1 a. Explain various communication channels for digital communication. **(08 Marks)**

b. Bring out merits and demerits of digital communication over analog communication. **(04 Marks)**

c. Explain quadrature sampling of band pass signals. **(08 Marks)**

2 a. What is flat top sampling? Derive an expression for the flat top sampled signal. **(07 Marks)**

b. Explain time division multiplexing (TDM). **(05 Marks)**

c. A signal $x(t) = 2 \cos 400\pi t + 6 \cos 640\pi t$ is ideally sampled at $f_s = 500HZ$. If the sampled signal is passed through an ideal low pass filter with cut off frequency $f_c = 400HZ$ find :

i) X(f) and sketch its spectrum.

ii) Sampled signal $X_\delta(f)$ and sketch its spectrum.

iii) The components that will appear at the filter out put. **(08 Marks)**

3 a. What is the necessity of non uniform quantization? Explain two compounding methods used in practice. **(06 Marks)**

b. With diagrams, explain in detail, the operation of DPCM transmitter and receiver. **(10 Marks)**

c. A telephone signal with hand width 4KHz is digitized in to an 8-bit PCM; sampled at Nyquist rate. Calculate PCM transmission band width and signal to quantization noise ratio (SNR). **(04 Marks)**

4 a. Explain T_1 carrier system. **(06 Marks)**

b. Explain, how raised cosine spectrum can be used to reduce ISI. **(06 Marks)**

c. A binary data sequence is 10011011. Sketch the wave form for the following formats :
i) Unipolar RZ ii) Polar NRZ. **(04 Marks)**

d. The output of a digital computer is at a rate of 64 kbps. Find the bandwidth required to transmit the data using a binary PAM system with a raised cosine spectrum if the roll off factors $\alpha = 1$ and 0.25. **(04 Marks)**

5 a. Explain Duo binary signaling schemes and obtain the transfer function of the Duo-binary filter (without precoder). **(07 Marks)**

b. Explain the need for a precoder in duo binary signaling. For input binary data 1011101, obtain the output of precoder, duo binary uncoder output and decoder output. **(09 Marks)**

c. Write a note on 'equalization'. **(04 Marks)**

6 a. With a diagram, explain FSK coherent detection. **(07 Marks)**

b. Explain :

i) Quadrature Phase shift keying ii) Differtial Phase shift keying. **(08 Marks)**

c. Explain M-ary modulation techniques. **(05 Marks)**

7 a. Show that the probability of bit error of a matched filter receiver is given by

$$P_e = \frac{1}{2}\,\text{erfc}\sqrt{\frac{E_b}{N_o}}$$ **(08 Marks)**

b. Explain maximum likely hood estimator. **(06 Marks)**

c. A binary data is transmitted using ASK over a AWGN channel at a rate of 2.4 Mbps. The carrier amplitude at the receiver is 1 mv.

The noise power spectral density $\frac{N_o}{2} = 10^{-15}$ Watt/Hz. Find the average probability of error if the detection is coherent. (Hint : take $\text{erfc}(5) \approx 3 \times 10^{-6}$) **(06 Marks)**

8 a. Define spread spectrum. Explain the principle of direct sequence spread spectrum system. **(09 Marks)**

b. Explain :

i) Slow frequency hopping.

ii) Fast frequency hopping. **(08 Marks)**

c. A slow FH/MHSK has the following parameters

Number of bits/MFSK symbol = 4

Number of MFSK symbols/hop = 5.

Find the processing gain of the system. **(03 Marks)**

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EC61

Sixth Semester B.E. Degree Examination, June/July 08
Digital Communication

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. State and prove sampling and reconstruction of low pass signals using Nyquist criterion. **(07 Marks)**

b. Signal $g(t) = 2\cos 400\pi t + 6\cos 640\pi t$ is ideally sampled at $f_s = 500Hz$. If the sampled signal is passed through an ideal low pass filter with a cut off frequency 400 Hz. What frequency components will appear at the filter output? **(05 Marks)**

c. Prove that mean square error of reconstructed message process is zero for wide sense stationary message process whose power spectral density is strictly bandlimited. **(08 Marks)**

2 a. Show that shifted sinc functions used in reconstruction of sampled signals i.e. sinc(2wt-n) are mutually orthogonal. **(05 Marks)**

b. Explain the practical procedure for sampling. State and prove flat top sampling. **(10 Marks)**

c. Six independent message sources of bandwidths w, w, 2w, 2w, 3w and 3w are to be transmitted on a time division multiplexing basis using common channel. Set up a scheme for accomplishing this with each message being sampled at its Nyquist rate. Determine the minimum transmission bandwidth of channel. **(05 Marks)**

3 a. Derive the expression for probability of error to estimate the performance of PCM system transmitted along channel associated with AWGN. **(08 Marks)**

b. Signal $m(t) = 6\sin 2\pi t$ is transmitted using 4 bit PCM system. Quantizer is of midriser type with step size 1 V. Sketch the PCM for one complete cycle. Assume sampling rate of 4 samples/sec with samples taken at $t = \pm 1/8, \pm 3/8, \pm 5/8$ secs. **(06 Marks)**

c. Derive the SNR of delta modulator for no slope overload conditon and with an input $x(t) = a_0 \cos 2\pi f_0 t$. Further obtain SNR for a case where receiver output contains low pass filter, whose bandwidth is set equal to message bandwidth w such that $f_0 \leq w$. **(06 Marks)**

4 a. Given the binary sequence 011010110 construct polar NRZ, unipolar NRZ, Bipolar, Manchester and natural quarternary line codes. **(05 Marks)**

b. Derive the Nyquist criterion for distortionless baseband binary transmission and mention its practical limitation and solution for it. **(07 Marks)**

c. What is correlative coding? Explain duobinary coding with and without precoding. **(08 Marks)**

5 a. Derive an expression for probability of error in binary FSK generation and coherent detection. **(08 Marks)**

b. Explain with neat block diagram the coherent QPSK transmitter and receiver. For a given binary sequence 01101000. Draw the signal space representation and relevant QPSK waveforms. **(08 Marks)**

c. Binary data is transmitted over AWGN channel using BPSK at a rate of 1 Mbps. It is desired to have average probability of error $P_e \leq 10^{-4}$. Noise PSD is $N_0/2 = 10^{-12}$ watt/Hz. Determine the average carrier power required at receiver input if the detector is of coherent type. [Assume erfc (3.5) = 0.00025]. **(04 Marks)**

6 a. Explain the properties of matched filter. **(08 Marks)**

b. 3 signals $S_1(t)$, $S_2(t)$ and $S_3(t)$ are as shown in figure Q6 (b). Apply Gram Schmidt orghogonalisation to obtain ortho normal basis functions for signals. Express the signals $S_1(t)$, $S_2(t)$ and $S_3(t)$ in terms of ortho normal basis functions. **(08 Marks)**

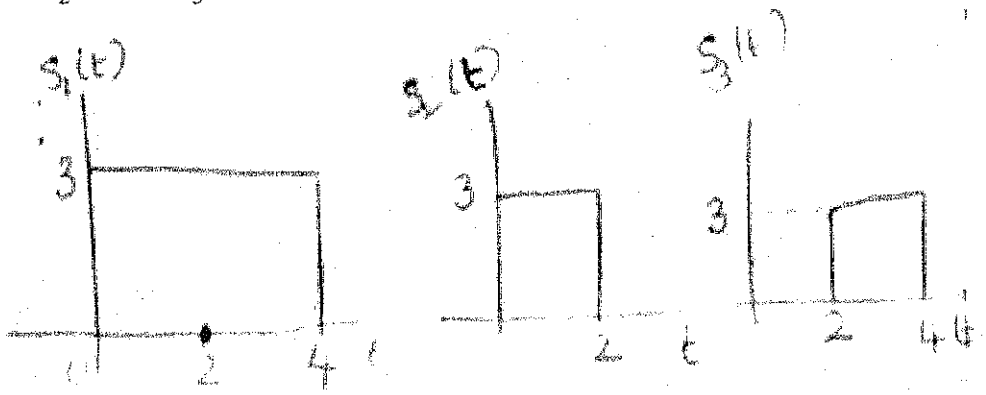

Fig. Q6 (b)

c. List the function of correlation receiver. **(04 Marks)**

7 a. What is spread spectrum? What is the role of PN code in spread spectrum? **(04 Marks)**

b. Explain the properties of maximum length sequence for a sequence generated from 3 stage shift register with linear feed back. Verifty these properties and determine the period of the given PN sequence 01011100101110. **(06 Marks)**

c. Explain with block diagram the model of direct sequence spread binary PSK system. **(10 Marks)**

8 Write explanatory notes on any four of the following:

a. DPCM transmitter and receiver.

b. Digital multiplex T_1.

c. Speech coding at low bit rates.

d. Maximum likelihood estimate and mean square error estimate.

e. Eye pattern and adaptive equalization. **(20 Marks)**

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06EC61

Sixth Semester B.E. Degree Examination, June-July 2009
Digital Communication

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each Part A and Part B.***
2. Missing data may be suitably assumed.

PART – A

1 a. Obtain an expression for Fourier Transform of a sampled signal. Assume flat top sampling. **(08 Marks)**

b. A bandpass signal g(t) with a spectrum shown below figure Q1 (b) is ideally sampled. Sketch the spectrum of sampled signals at $f_s = 25$ and 45 Hz. Indicate if and how the signal can be recovered. **(08 Marks)**

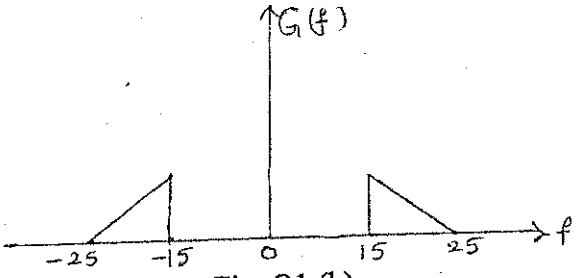

Fig. Q1 (b)

c. What is 'aperture effect'? How is it eliminated? **(04 Marks)**

2 a. Explain the need for nonuniform quantization. Also explain μ-law and A-law companding. **(08 Marks)**

b. If E denotes the energy of a strictly bandlimited signal g(t), then prove that $E = \frac{1}{2\omega}\sum_{n=-\infty}^{\infty}\left|g\left(\frac{n}{2\omega}\right)\right|^2$, where ω is the highest frequency component of g(t). **(06 Marks)**

c. The signal $g(t) = 2\cos(2000\pi t) - 4\sin(4000\pi t)$ is quantized by rounding off, using a 12-bit quantizer. What is the rms quantization error and the quantization SNR? **(06 Marks)**

3 a. Consider a speech signal with a maximum frequency of 3.4 kHz and maximum amplitude of 1 volt. The speech signal is applied to a D.M. with its bit rate at 20 kbits/sec. Discuss the choice of an appropriate stepsize for the delta modulator. **(05 Marks)**

b. Compare PCM and DPCM. **(04 Marks)**

c. Obtain power spectral density of NRZ bipolar format and draw its normalized PSD. **(11 Marks)**

4 a. Design a binary baseband PAM system to transmit data at a bit rate of 3600 bits/sec, with a bit error probability $< 10^{-4}$. The channel response is given by,

$$H_C(f) = \begin{cases} 10^{-2} & |f| < 2400 \\ 0 & \text{elsewhere} \end{cases}$$

The noise power spectral density is $G_n(f) = 10^{-14}$ watts/Hz, $Q(y) \le 10^{-4}$, $y \ge 3.75$, parameter $\beta = \frac{r_b}{6}$. **(10 Marks)**

b. A binary data sequence is 011011. Sketch the waveform for the following formats: **(04 Marks)**
i) RZ unipolar ii) NRZ Bipolar

c. With a neat structure, explain the concept of the adaptive equalization process. **(06 Marks)**

PART – B

5 a. Explain with a neat block diagram the coherent QPSK Transmitter and Receiver. **(08 Marks)**

b. A binary FSK system transmits data at a rate of 2MBPS over an AWGN channel. The noise is zero mean with PSD, $\frac{N_0}{2} = 10^{-20}\,W/Hz$. The amplitude of received signal in the absence of noise is 1 μV. Determine the average probability of error for coherent detection of FSK. Take $erfc\sqrt{6.25} = 0.00041$ **(06 Marks)**

c. Show that the energy of signal $S_i(t)$ is equal to the square of length of the corresponding vector S_i. **(06 Marks)**

6 a. What do you mean by an optimum receiver with reference to a digital modulation scheme? Write the scheme of a correlation receiver and describe its features. **(06 Marks)**

b. Find the output of the matched filter and determine the maximum value of $\frac{S}{N_0}$ if the input s(t) is a rectangular pulse of amplitude A and duration T. **(08 Marks)**

c. Calculate the bandwidth efficiency of an M-ary signaling scheme. **(06 Marks)**

7 a. Consider the set of signals,

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

where i = 0, 1, 2, 3 and f_c is an integer multiple of $\frac{1}{T}$.

i) Determine the dimensionality N of the signal set.
ii) Determine a set of orthogonality N of the signal set.
iii) Determine the coefficients S_{ij} of the signals $S_i(t)$.
iv) Give the signal constellation diagram. **(10 Marks)**

b. What is spread spectrum communication? What is its primary advantage? What are the commonly used spread spectrum technique? **(07 Marks)**

c. Write the applications of spread spectrum technique. **(03 Marks)**

8 Write short notes on:

a. Duobinary signaling.
b. Eye pattern.
c. Correlation receiver.
d. TDM. **(20 Marks)**

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06EC61

Sixth Semester BE Degree Examination, Dec.09-Jan.10
Digital Communication

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Missing data may be suitably assumed.

PART – A

1 a. Explain merits of digital communication system over analog communication system. **(04 Marks)**

b. Obtain the expression for Fourier transform of sampling function h(t) used for flat top sampling. Hence explain aperture effect with the help of spectral diagrams. Bring out the differences between aperture effect and aliasing effect. **(08 Marks)**

c. Four messages bandlimited to w, w, w and 3w are to be time division multiplexed, with w being 2000 Hz. Se up a TDM scheme for the same and find speed of the commutator in samples per second. **(08 Marks)**

2 a. A signal x(t) is uniformely distributed in the range $\pm x_{max}$. Calculate signal to noise ratio for pulse code modulation of this signal. **(08 Marks)**

b. Draw the output of midtread type uniform quantizer for one complete cycle of a sinusoidal modulating signal. **(06 Marks)**

c. A 10 KHz sinusoid with amplitude 1V peak is quantized to have SNR of about 45 dB. Find the number of bits required per sample, bit rate and bandwidth of the system if sampling frequency is twice the Nyquist rate. **(06 Marks)**

3 a. Explain DPCM with neat diagrams for transmitter and receiver and relevant mathematical equations. **(07 Marks)**

b. Derive the condition for no slope overload distortion in delta modulation system. Hence derive the expression for post filtered signal to noise ratio. **(09 Marks)**

c. Draw the output of a delta modulator for input m(t) = 0.01t when sampled with fs = 20 Hz. **(04 Marks)**

4 a. Define intersymbol interference and explain ideal solution for zero ISI. **(08 Marks)**

b. Explain modified duobinary coding with precoder. **(08 Marks)**

c. A binary PAM wave is required to be transmitted via a channel having bandwidth 75 kHz. The bit duration is 10 μsec. Find a raised cosine pulse spectrum that satisfies these requirements. **(04 Marks)**

PART – B

5 a. A binary signal transmitted using PSK has the bitrate of 100 kilobits per second. Sketch the PSK wave form for binary data 110 if carrier frequency used has frequency $f_c = 1/t_c$, where $3t_c = T_b$. **(04 Marks)**

b. Explain coherent PSK receiver. Obtain the expression for probability of error for PSK with coherent receiver. **(10 Marks)**

c. A binary data is transmitted using ASK over AWGN channel at a rate of 2.4 Mbps. The carrier amplitude at the receiver is 1mv. Noise power spectral density is $No/2 = 10^{-15}$ watts/Hz. Find the average probability of error if detector is coherent. Take $erfc(5) \cong 3 \times 10^{-6}$. **(06 Marks)**

6 a. Give the steps used for finding basis functions using orthogonalization procedure, for N = 2. **(06 Marks)**

b. Define MAP criteria in a receiver and explain how ML criterion is used in correlation receiver. **(14 Marks)**

7 a. Derive the expression for SNR for a matched filter. **(10 Marks)**

b. Explain fast frequency hop spread spectrum system. **(10 Marks)**

8 Write notes on:

a. Robust quantization **(07 Marks)**

b. TI system **(07 Marks)**

c. Notion of spread spectrum system. **(06 Marks)**

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