B.E. Part III, 5th Semester Final Examination, 2011

Digital Communication (ET 501)(ETC Branch)

Full Marks: 70 **Time: 3 hours**

Attempt any five questions from the following
Answer should be brief and to the point
Unnecessary length answers may result in loss of marks

1. (a) Consider a mid-tread type uniform quantizer. Assume that a Gaussian-distributed random variable with zero mean and unit variance is applied to this quantizer input. What is the probability that the amplitude of the input lies outside the range -4 to +4? Show that the output signal-to-noise ratio of the quantizer is given by $(SNR)_o = 6R - 7.2\ dB$, where R is the number ~~of bits per sample.~~ Specifically, you may assume that the quantizer input extends from -4 to +4.
(b) "DM is a special kind of DPCM"- Justify.
(c) Given the data stream 1 1 1 0 0 1 0 1 0 0, sketch the transmitted sequence of pulses for Bipolar RZ and Manchester code.
8+2+4

2. (a) In a practical digital communication system, matched filter has been realized by means of a simple resistance-capacitance (RC) low-pass filter. The frequency response of this filter is $H(f) = \frac{1}{1+j\frac{f}{f_0}}$, where $f_0 = \frac{1}{2\pi RC}$. The input signal is a rectangular pulse of amplitude A and duration T. The requirement is to optimize the selection of the 3-dB cutoff frequency f_0 of the filter so that the peak pulse signal-to-noise ratio at the filter output is maximized. With this objective in mind, show that the optimum value of f_0 is $\frac{0.2}{T}$, for which the loss in signal-to-noise ratio compared to the matched filter is about 1 dB.
(b) Prove that the unipolar RZ type of signaling requires twice the average power than unipolar NRZ signaling for the same average probability of symbol error.
10+4

3. (a) Briefly point out that how can you select the value for roll-off factor of pulse-shaping filter in order to ensure an efficient as well as reliable transmission.
(b) Assume that the bit stream 1 0 0 1 1 is being transmitted by bipolar pulses through a band-limited channel. Draw the transfer function of the ideal minimum-bandwidth pulse shaping filter at the transmitter for no ISI and sketch the received channel output in time domain.
(c) Calculate the exact frequency at which the raised cosine channel has a 30-dB attenuation. Assume that roll-off factor is equal to 0.3 and that the Nyquist frequency is at 500 KHz.
3+5+6

4. Consider a random process $d(n)$ which is having an autocorrelation sequence $r_d(k) = \alpha^{|k|}$, with $0 < \alpha < 1$, and suppose that $d(n)$ is observed in the presence of uncorrelated white noise, $v(n)$, that has a variance of σ_v^2. Design a first-order FIR Wiener equalizer filter to reduce the noise and hence calculate the minimum mean square error value for $\alpha = 0.8$ and $\sigma_v^2 = 1$. Derive all the necessary equations with proper justifications which may be required for this purpose.
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5. (a) Define bandwidth efficiency.
(b) Given the input binary sequence 1 1 0 0 1 0 0 0 1 0, sketch the waveforms of the in-phase and quadrature components of a modulated wave obtained by using QPSK modulation.
(c) Draw the constellation diagram for $\pi/4 - shifted\ QPSK$ modulation and also indicate the possible phase transitions.
(d) "BFSK is neither bandwidth efficient nor power efficient than BPSK. Still the frequency of the carrier signal is sometimes varied in accordance with the message information using BFSK". Why?
2+6+4+2

6. (a) For the feedback shift register given in Fig. 1, demonstrate the balance property and run property of a PN sequence. Also, calculate and plot the autocorrelation function of the PN sequence produced by this shift register.

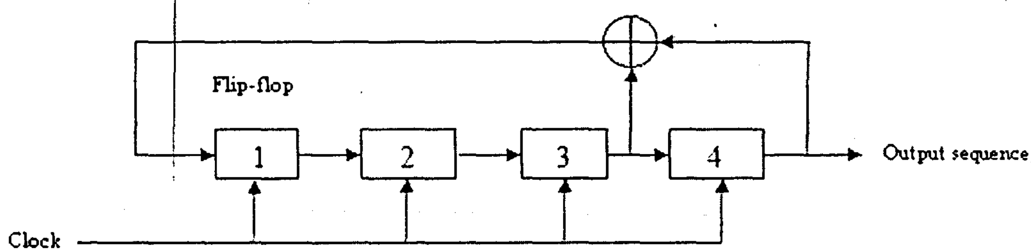

Fig. 1

(b) Neatly draw the transmitter and receiver block diagram of a direct-sequence spread coherent phase-shift keying modulated system.

10+4

7. (a) A discrete memory-less source has an alphabet of seven symbols whose probabilities of occurrence are as described:

Symbol	s_0	s_1	s_2	s_3	s_4	s_5	s_6
Probability	0.25	0.25	0.125	0.125	0.125	0.0625	0.0625

Compute the Huffman code for this source, moving a combined symbol as high as possible. Explain why the computed source code has an efficiency of 100 percent.

(b) Consider the binary sequence 1 1 1 0 1 0 0 1 1 0 0 0 1 0 1 1 0 1 0 0 . . .

Use the Lempel-Ziv algorithm to encode this sequence. Assume that the binary symbols 0 and 1 are already in the codebook.

8+6

8. (a) Define Hamming weight, Minimum distance and Constraint length with proper examples.

(b) "All error patterns that differ by a code word have the same syndrome"-Prove the statement.

(c) Consider the 0.5 rate convolutional encoder of Fig. 2. Find the encoder output produced by the message sequence 1 0 1 1 1 . . .

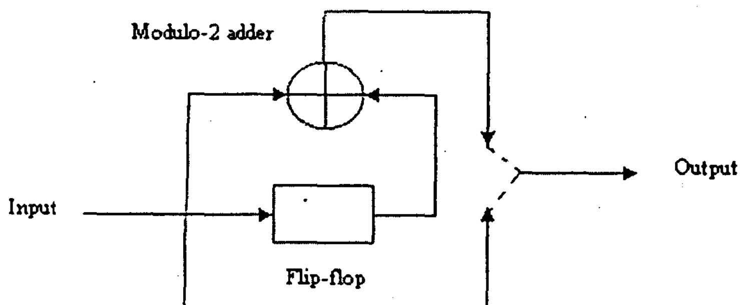

Fig. 2

6+3+5

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